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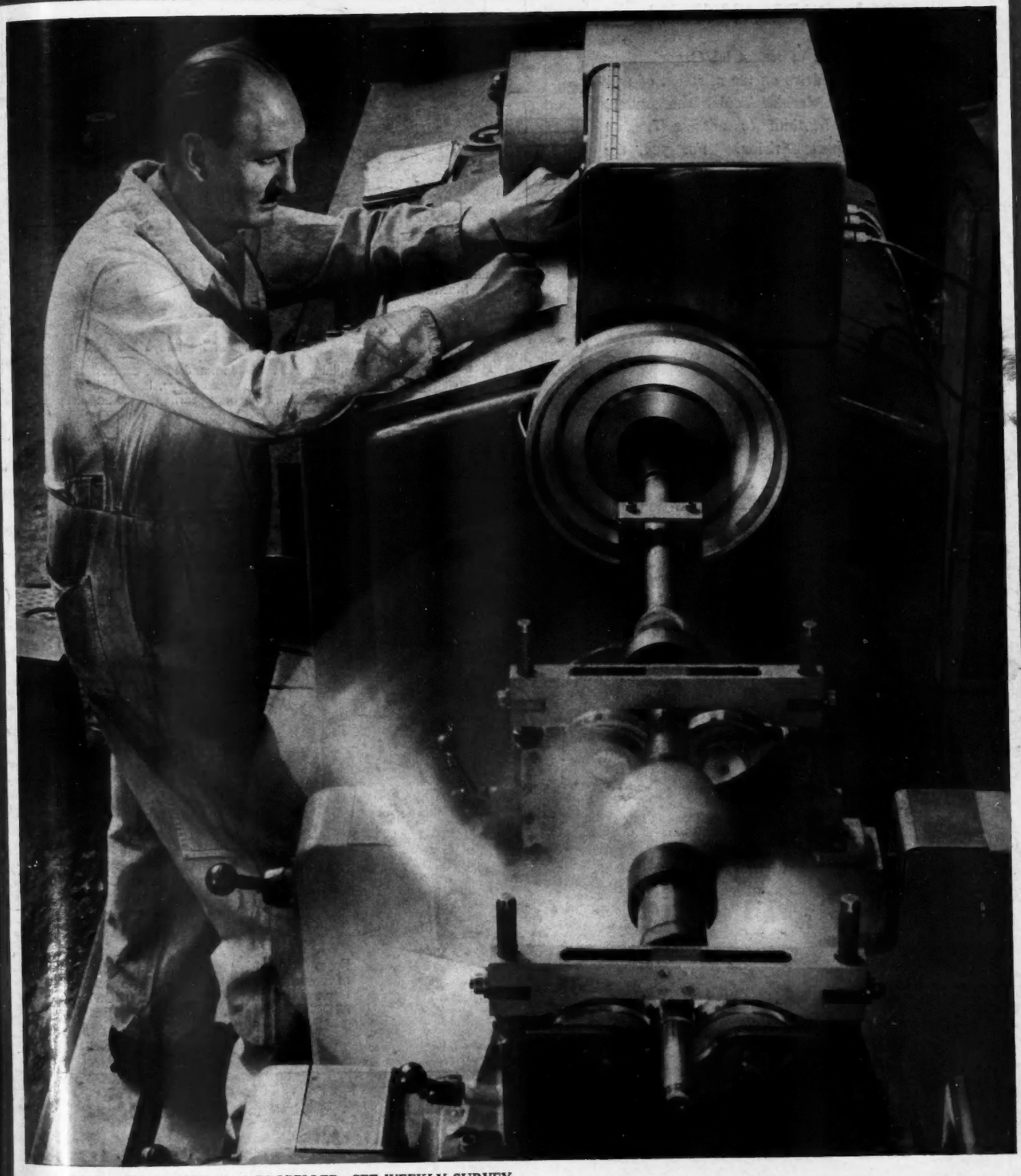

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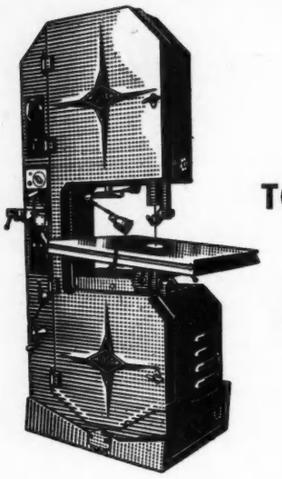

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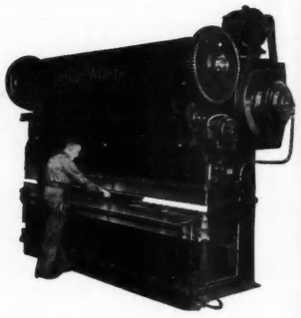

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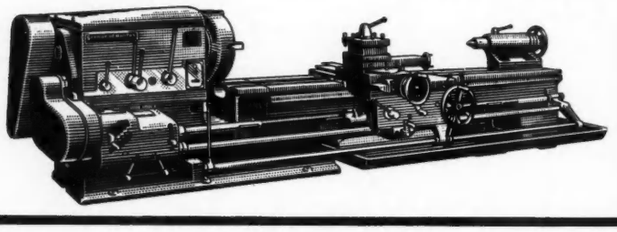

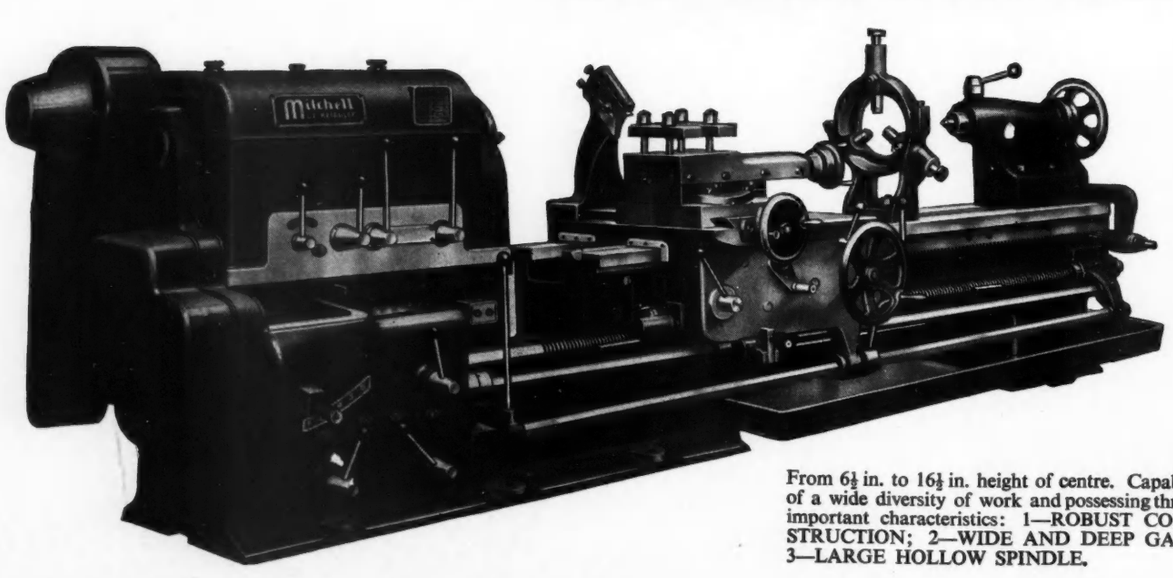

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OVERSEAS FRIENDS

BRITISH engineers are going about the world. In foreign lands, in undeveloped countries and in highly-industrialised states, they are continuing the good work which their grandfathers developed in the Nineteenth Century. Some go as consultants, others as contractors; as teachers, as advance parties of new overseas branches; to seek out trade and to bring trade. "Mr. E leaves London Airport on . . . to visit . . ." so run the Press releases. But many of the tours pass unrecorded, except in office files. Is there more travel of this kind to-day than there was fifty years ago? There should be, because travel is now so much easier. There is more to be done, too. Hardly a country remains which is not striving to make up for lost time in the World Industrial Revolution. And in striving, old differences are forgotten on both sides: engineers succeed where politicians fail.

Apart from overseas travel for their firms, many engineers are sent out under the auspices of a national or international agency. Mr. J. W. McQuair, of the Automatic Telephone and Electric Company, has recently returned from a visit to Yugoslavia, where he spent four months advising on improved production methods. He went there under arrangements made by the United Nations as part of its programme of technical assistance to "less-developed" countries. On a larger scale, British locomotive builders have helped India—one of its best customers in the past—to establish its own locomotive industry.

There was a gathering of young engineers from overseas in London last week. More accurately, it was in Westminster—the headquarters of British engineers and engineering as well as the seat of government. The Federation of British Industries were holding the first annual reunion of their Overseas Scholars. At dinner on Thursday evening the tables carried the names of the countries represented—Australia, India, Argentina, Chile, Colombia, Cuba, Mexico, Peru. In the chair was the Director-General of the F·B.I., Sir Norman Kipping, and with him at the top table were the High Commissioner for Australia, Sir Thomas White, together with ambassadors and representatives of the states and departments directly concerned. The principal guest was the Rt. Hon. Selwyn Lloyd, Minister of Supply and formerly Britain's representative in the United Nations. He proposed the toast of the F.B.I. Overseas Scholars.

"You have come," he said, "to gain knowledge of British engineering. You are very welcome. There was a time when most of the capital investment throughout the world came from Britain. We have spent much of our accumulated wealth in defending democracy and independence against tyranny in two world wars. We are exporting capital now to the limit of our capacity, but we can supply much less than we should like, or is needed. What we have freely available, however, are our technical skills."

The Minister was addressing about 46 Scholars. They are all graduate engineers, some with several years' experience before they came to Britain. The scheme was started in 1950 and has grown steadily since. Scholars come for one or two years to work in British firms, to become acquainted with British engineering and its products, and to make friends, so that on returning to their home countries and taking part in furthering engineering development there, they will invariably turn to British firms when, as will often happen, they want plant, equipment and the services of consultants. Most of them will occupy important positions at an earlier age than is common in this country, because their countries are developing more rapidly. From the point of view of the British firms with whom they have served, the F.B.I. Overseas Scholarships scheme represents a modest investment which is likely to bear fruit many times.

The object is not, of course, to enable visitors from abroad to gain knowledge and experience at our expense and then, perhaps, to compete with us. The F.B.I. have faced up to the unalterable fact that many countries are in the throes of an industrial revolution; that if British firms deny those countries assistance now they will suffer, in loss of trade, in the not very distant future. The firms who have accepted Scholars so far—their names are given on page 36—have made friends who will quickly become influential and active abroad.

Small and medium-size engineering firms are likely to benefit most, in relation to their size, from having one or two Scholars. It is not necessary to have a graduate-training scheme already in operation in the works. Indeed the Scholars do not come to be trained in the ordinary way, but to make contacts at a fairly senior level and to be able to return to their homes with a clear impression—a conviction, one might say—of the supremacy of British engineers and engineering. The scheme is financed jointly by the Government, the F.B.I. and the firms. Each firm, for the price of a single air trip of one of its executives to an overseas country (a trip which is soon forgotten by the people visited) cements a friendship which will not be forgotten in a life-time. It will not be forgotten personally, nor when trade is being considered. Welcome to friends from overseas!

Weekly Survey

Cover Picture: *A three-bladed marine propeller being checked for dynamic balance. Modern electrical machines, several examples of which have been described in ENGINEERING in recent years, simplify the work of dynamic balancing and can be used for many components, including rotors, crankshafts, etc.*

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RAILWAYS IN THE FUTURE

Just a week ago the interim report of the court of inquiry into the railway dispute was the means of averting a strike. It also set a ticklish problem for Parliament to discuss when it re-assembles on January 25.

The fact that the British Transport Commission is unable both to pay adequate wages (and salaries) and to make a profit, " taking one year with another," is the clearest evidence that too much has been left undone for too long on British Railways. Largely owing to Government post-war policy, it has only been possible to maintain existing equipment, at a time when great schemes of improvement should have been in hand. An announcement is expected soon on major plans which have been approved by the Minister of Transport. It is apparent that these plans will be for very large schemes. The steam locomotive has been " counted out " with varying degrees of certainty for the past 50 years but it has held its place. Within a few months, however, its end as the chief form of motive power on British Railways should be in sight.

Electrification and Diesel traction have proved their value not only in direct savings but also in stimulating increased traffic. The re-instatement of electric trains on the Lancaster, Morecambe and Heysham services and the use of light-weight Diesel trains in the West Riding of Yorkshire are recent examples.

But if the big schemes of the next decade—involving considerable investment of national resources—are to benefit industry and the country generally on the optimum scale, brilliant direction will be required at the top. The Commission must be a policy-formulating body with complete detachment from executive problems. The functional pattern of railway organisation is of no use in a Commission which controls such a vast organisation. A Government committee inquiring into the working of the railways, and motivated by a national sense of grievance over financial losses, would do more harm than good. What railwaymen want—and what the country wants—is a profit-making Commission. The brains and experience are available. The only thing lacking is a Commission organised on the right lines.

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COAL SUPPLIES

Parallels are being drawn between the railways and the coal industry, where since nationalisation heavy capital expenditure has already been incurred without as yet either increasing production to the level required or reducing the price of coal.

In these discussions there has been a tendency to ignore the very real differences between the two industries. In an article in the 1955 *Fuel Economy Review*, published by the Federation of British Industries, Sir Hubert Houldsworth drew attention to some of the special problems of the coal industry. He pointed out that because coal mining is an extractive industry there is an annual loss of capacity of the order of four to five million tons. This is not analogous to depreciation of plant in manufacturing industries because where new seams are opened up they are often thinner and more difficult to work than those which have been exhausted. This means that ten years of coal-getting without any opening up of new collieries or major re-organisation schemes would result in a fall in production capacity of 40 to 50 million tons per annum.

Inland coal consumption fell steadily during the 1920's but since 1930 it has been rising at a rate comparable to that of the years 1870 to 1910. As a result, in spite of an increase of 30 million tons in the output of deep-mined coal in the first seven years after nationalisation, it has only been possible to meet the needs of the home market because of a fall of nearly 40 million tons in exports, the development of opencast mining and the import of coal. Sir Hubert goes on to say that it takes eight to ten years before a new pit can be brought into production and six to seven to carry through a large-scale reconstruction scheme. The results which it has been possible to achieve in the last seven years are therefore strictly limited, but it is expected that from 1957 onwards the completion of some major reconstruction schemes should help further, and the Board's plans have been revised with the aim of expanding output by 1965 to about 250 million tons per annum instead of the 240 million tons originally contemplated.

The fact that this represents the upper limit of probable expansion over the next ten years emphasises the need for the maximum degree of fuel economy, particularly in the short term, since in the long run appreciable relief will be obtained from the development of alternative sources of fuel and power, for example, atomic energy. Regarding the possibility of increased use of petroleum products, Mr. C. M. Vignoles, managing director of Shell-Mex and B.P., said in a recent address to the Coal Industry Society that, hitherto, the oil industry had adopted a selective policy aimed to encourage the use of fuel oil in those sectors of the economy where most advantage could be taken of its higher efficiency of utilisation. However, there was already a tendency for the supply of fuel oil to be restricted by a fall in the demand for lighter fractions, including petrol, due to increases in taxation. Mr. Vignoles made the suggestion that one of the outstanding fuel economies that could be made was in the adoption of Diesel-driven or Diesel-electric locomotives, which might result in the replacement of about 13 million tons of coal per annum by 2·5 million to 3 million tons of Diesel oil. This is certainly one of the ways in which greatly increased efficiency, both as regards operation and labour utilisation, will be achieved by the railways.

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MATERIALS IN ENGINEERING

The conclusions of the Engineering Outlook article on page 42 are generally optimistic. The only really serious shortage in materials likely to hamper production in the British engineering industry is that of nickel, the supply of which is likely to continue to fall short of current needs by at least one-fifth. Steel is not over-plentiful, and there may be marginal shortages of flat products despite an estimated increase in output at Margam, Ebbw Vale, and Shotton of 10 to 15 per cent. It is assumed, of course, that the output performance of the motor-car industry which has already surpassed the best expectations of five years ago will continue to improve. The iron and steel industry is already taking account of the possible need of a further major expansion in sheet-making capacity, which may involve the erection of a large modern strip mill of a million tons capacity with associated iron and steel-making facilities and costing £100 million (see the special article on this subject on page 36).

Abroad, large expansions programmes for increasing the output of non-ferrous metals are being put in hand. Copper production in Northern Rhodesia should increase by a quarter to 500,000 tons per annum by 1958, and an even greater expansion is scheduled to take place in the United States where production is expected to rise by 250,000 tons a year by 1956-57. The aluminium expansion programmes are ambitious. Plans are approved to expand output at Kitimat by 60,000 tons so that capacity in 1956 will be about halfway towards the goal of 300,000 tons. There is also a possibility that a large new plant will be erected at Skagway, Alaska. These large schemes betoken a high degree of confidence in the future level of world economic activity which may not be altogether justified. Nevertheless, demand for metals is likely to be very strong in 1955, and British engineers may have to pay more for their supplies. But for the American recession in 1954, the rise in the price index of materials used in mechanical engineering (5 per cent.) might have been much greater. An increase of 10 per cent. in the current year is well within the bounds of possibility. This has important implications for the British terms of trade, and may necessitate a higher volume of exports.

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CARL ZEISS

When Eastern Germany including Jena, the home of the Carl Zeiss organisation, was occupied by Soviet troops in 1945, concern was felt in many countries that Zeiss instruments might no longer be available to the Western world. In 1946 the Jena works were largely dismantled and over 300 workmen and their families taken to Russia; however, three days before the Russians assumed control, the board of directors and some 80 scientists and engineers of the company withdrew to Western Germany and established a new factory at Oberkochen in the American Zone.

At Oberkochen, with little more than their skill and the traditions founded by Carl Zeiss and Ernst Abbe nearly a century ago, this group of experts rebuilt the company so that now, together with associated firms, it employs more than 20,000 people. Since the war manufacture of optical and metrological instruments and equipment has been resumed and current products include microscopes, binoculars, surveying instruments, opthalmic and other medical diagnostic equipment, industrial optical instruments and spectacles. In addition, it is expected that Carl Zeiss will make the projection equipment for a new planetarium which Madame Tussaud's Limited propose to erect in London.

The agents for Carl Zeiss in the United Kingdom are Degenhardt and Company, Limited, 32 Maddox-street, London, W.1.

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THE COPPER BELT

Since the first mine, the Kansanski, was discovered in 1902, enormous difficulties have been overcome to make Northern Rhodesia second only to the United States among the copper-producing countries of the world. Northern Rhodesian output, which first exceeded that of Chile in 1953, has now an annual export value of £100 millions. This figure, quoted by Mr. R. L. Prain, O.B.E., Chairman of the Rhodesian Selection Trust Group in his Henry Morley Lecture to the Commonwealth Section of the Royal Society of Arts on January 6, assumes a price of £250 per ton. The price of copper is at present £300 per ton. According to Mr. Prain, two major difficulties still confront the industry, namely, the social problem created by the existence of two civilisations working and living together, and the economic problem of providing sufficient power. The wages obtained in the copper mines by African workers are higher than they could obtain elsewhere, but it is not surprising that (as witness the present unrest) there is increasing pressure for greater equality with white workers. The problem of power supply is equally complex, involving three factors: fuel supplies, transport, and electricity-generating capacity. Wankie Colliery in Southern Rhodesia at present provides the bulk of natural fuel supplies, although 7,000 Africans are at present employed in cutting wood in the local forest. The principal difficulty is the failure of the Rhodesian Railway system to deliver the

Copper belt's full requirements of 90,000 tons of coal a month. At present, only about 70,000 tons are being received, and the deficiency has to be made good by burning wood.

In due course, the problem may be solved by the availability of hydro-electric power. By 1957 when the Copper belt's power requirements are estimated at 196 MW, it is estimated that it will be possible to obtain 50 MW from the hydro-electric scheme on the Lualaba River in the Congo. By 1961, when Rhodesian hydro-electric power should be available, it is hoped that hydro-electric sources will supply 150 MW out of total power requirements of 220 MW. The Rhodesian Railway system remains, however, a key factor in the ability of the Copper belt to achieve full production in the next few years—hence the recent decision of the Rhodesian Anglo-American Group to make a loan of £1 million for the purchase of rolling stock.

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RADIO AND TELEVISION

It is now becoming possible to form some idea of the impact on the radio industry of the recent relaxation in hire-purchase controls. From provisional figures it would appear that the sale of radio sets in October was about £1,700 millions which is 30 per cent. higher than in September and almost three times as high as the monthly average sales for 1953. An impressive increase has also been recorded in sales of television receivers. It is probable that in October they were over £7 millions, which is about 38 per cent. higher than in September and more than twice the monthly average level of the previous year. The television receiver sales for October in fact bear comparison with the record levels achieved in May 1953, immediately before the Coronation. It would be expected that sales of television receivers would be higher by now than those of radio sets and it is therefore particularly interesting that although television-receiver sales were in fact running at about four times the value of radio receivers last autumn, the rate of increase in the sales of radio sets was much the larger of the two. It may well be that the challenge of the radio set to television will be much more sustained than might at first appear, particularly when the very high frequency sound coverage is extended to bring Home, Light and Third programmes to a much wider listening public than at present.

It had been thought that sound radio, with such help as very high frequency broadcasting might be able to give it, would have to compete against television on increasingly disadvantageous terms. The recent sales figures of sound radio may cause a modification in this view, but on the other hand, there are indications that colour television may become a commercial proposition in this country sooner than had been expected. The Director General of the B.B.C. made encouraging references to this recently, and the efforts to develop techniques which will bring colour-vision within the pocket of the mass market are going on unabated. A new form of colour T.V. receiver was demonstrated last week at an exhibition of the Television Society at University College, London. This is a multi "gun" cathode-ray tube in which each of four "guns" project on to the face of the tube. This tube is divided into four equal segments which record the same picture in different colours: red, green, blue and also in white. At the prototype stage this tube costs about £100 but it may be possible to bring it down to £35 when it gets into full production.

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HAWKER AND DEFENCE

After the disquieting debate in the House of Commons on the flow of fighter aircraft to the Royal Air Force which took place just before Christmas, the annual report of the chairman of the Hawker Siddeley Group makes uncontroversial reading. This is to be expected, for Sir Thomas Sopwith, like other chairmen of companies which are deeply implicated in the defence programme, is restrained from speaking his mind on matters of armament policy. It was clear from the debate in the House on December 17 that both the Government and the Opposition are concerned about the slow rate of delivery of fighter aircraft and the way in which the design and production problems have combined to prevent a steady flow of machines of advanced performance at an earlier stage in the defence programme. Sir Thomas was able, however, to give a certain amount of interesting information about the way in which his group have organised the production of several of their aircraft among their own factories. The Meteor is now out of production and the Javelin production line has taken its place at the Gloster works. Early production models of the Javelin are now flying. Sir W. G. Armstrong Whitworth (Aircraft) Limited have now arranged to take over all the Hawker company's surplus of Sea Hawks, so freeing the latter company to proceed unfettered with the production of the Hunter. The Armstrong Whitworth company are involved to some extent also with the production of the Javelin and the Hunter.

Four engines of the Armstrong Siddeley range of gas turbines are in production and have been installed in 10 British aircraft—the Sapphire, Mamba, Double Mamba and Viper. The latest version of the Sapphire has passed its official type test at 10,200 lb. thrust without re-heat and is now in production. Six American aircraft are powered with the Sapphire which is made under licence in the United States, and the reports on the Avro Canada Orenda jet are satisfactory. The Group is now represented in the field of guided missiles by Armstrong Siddeley Motors, Limited, who have been working on rocket motors for some time, and by A. V. Roe and Company, Limited, who have formed a Weapons Research Division. The Armstrong Whitworth company have been engaged on guided weapons for some time. Sir Thomas clearly approves of the Government's decision taken last year to do away with the established method of ordering only one or two prototypes and to supplement a prototype order with a much larger pre-production batch. This is expected to speed up deliveries of aircraft to the squadrons. As may be expected at this stage, the Avro Vulcan bomber receives only a passing mention.

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MARSHALL SONS & CO.

The production of certain classes of agricultural machinery and of agricultural and industrial tractors was running at a record level during 1954. While the output of the older standard equipment such as ploughs, disc harrows and corn drills appears to have reached a peak in 1951 or 1952, production of pick-up balers and combine harvesters is continuing to expand, and in the former case amounted to 5,571 units in the first six months of 1954 compared with 3,665 in the same period of 1953, the corresponding figures for combine harvesters being 3,437 and 2,404. Production of tracklaying tractors rose from 1,479 in the first six months of 1953 to 2,136 in the corresponding period of 1954, and of wheeled tractors from 54,586 to 68,542.

These developments are reflected in the financial results of Marshall Sons and Company, Limited, the parent company showing a profit of £229,105 for the year ended September 30, 1954, an increase of £4,564 over the previous year. The company's interests are, of course, very much wider than the range of products mentioned above. In addition to agricultural machinery, the products of the group include pressure vessels, boilers and heavy steel fabrications, road rollers, tea machinery, heavy Diesel crawler tractors, steel castings and wire and tube-drawing machinery.

In most of these fields a high proportion of the production of all British manufacturers is accounted for by exports. In the case of track-laying tractors, exports accounted for 65 per cent. of the total U.K. production in the first six months of 1954, the corresponding figure for wheeled tractors being over 70 per cent. Marshall Sons and Company are primarily concerned with the heavier classes of tractor and, while total U.K. exports of tractors up to 36 belt h.p. showed a slight decline in 1954, there was a very marked expansion in exports of the heavier types. Thus exports of agricultural tractors of 36 belt h.p. and over rose from 16,217 in the first 11 months of 1953 to 34,680 in the corresponding period of 1954, while the figure for the same group in the case of track-laying tractors were 900 and 1,792.

The production of road rollers in the United Kingdom reached a maximum of £258,000 per month in the third quarter of 1953, and has since fallen to £188,000 per month in the second quarter of 1954. This was due partly to a decline in exports in the early part of 1954, but there has probably been a recovery in production in the second half of the year since total exports in the eleven months to November, 1954, were slightly higher than for the corresponding period in 1953.

Tea machinery is also very largely an export business, total exports from the United Kingdom amounting to rather over £1 million per annum. In his statement circulated with the accounts, the chairman of Marshall Sons and Company, Limited, states that the company have recently concluded an agreement with the Britannia Engineering Company, Limited, of Calcutta, also manufacturers of tea machinery, for an interchange of technical information and designs and a rationalisation of sales and distribution.

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OXYGEN BY THE TON

Oxygen is now used so extensively in the manufacture of steel, the production of synthetic chemicals, and the gasification of coal and other fuels, that it is frequently required by a single works in quantities of several hundred tons a day. Such demands can only be met conveniently and economically by the erection of local installations for the production of oxygen on a large scale; these are known as "tonnage" oxygen plants. They are designed to supply gaseous oxygen, and sometimes nitrogen, in the quantities and qualities required, and to deliver the gases at appropriate pressures by pipeline directly to the consuming process.

Tonnage plants, the design of which depends on requirements and conditions of operation, vary widely, and there are, moreover, other processes which involve gas separation by similar techniques. To deal with all demands of this kind, the British Oxygen Company, Limited, Bridgewater House, Cleveland-row, St. James's, London, S.W.1, and Gesellschaft für Linde's Eismaschinen A.G., Wiesbaden, Germany, have formed a jointly-owned subsidiary company to be known as British Oxygen Linde, Limited. The headquarters of the joint technical and sales organisation is at Bridgewater House.

British Oxygen Linde will supply to industry oxygen plants designed and constructed by the British Oxygen Company and the German company, and will operate in the United Kingdom and in other parts of the world where B.O.C. have associated overseas companies, including many countries in the Commonwealth. The plants marketed by British Oxygen Linde will be built to produce high or medium purity oxygen economically, and may range in size from units costing about £150,000 with capacities of approximately 50 tons a day to £500,000 units producing each day several hundred tons.

In addition to their normal output of oxygen, these plants can provide supplies of nitrogen for bright annealing furnaces and other applications requiring an inert atmosphere. For ammonia synthesis, British Oxygen Linde plants are designed to yield high-purity nitrogen and medium-purity oxygen.

F.B.I. OVERSEAS SCHOLARS

First Annual Reunion

The Minister of Supply, Mr. Selwyn Lloyd, was the principal guest at the first annual reunion dinner of graduate engineers from overseas who hold scholarships arranged by the Federation of British Industries. The dinner was held at St. Ermin's Hotel, London, S.W.1, on January 6, and the chair was taken by Sir Norman Kipping, Director-General of the F.B.I. The names of the F.B.I. scholars, and the firms with whom they are serving, are given below. (Editorial comment, page 33.)

Argentine	
CHISTIK, R. J. M.	Vulcan Foundry Ltd.
MANASSERO, J. O.	J. & E. Hall Ltd.
MOLLO, V. E.	English Electric Co. Ltd.
SALINGER, G.	Power-Gas Corpn. Ltd.
SUDAK, L.	British Thomson-Houston Co. Ltd.
Australia	
BAIN, M. J.	Hoover Ltd.
BROOKER, E. L.	General Electric Co. Ltd.
BUCHAN, I.	Fairey Aviation Co. Ltd.
CAMPBELL, G. J.	Fraser & Chalmers Ltd.
CASLING, R. H.	Glenfield & Kennedy Ltd.
COWCHER, E.	General Electric Co. Ltd.
EARLE, R. F.	Vickers-Armstrongs Ltd.
FITZGERALD, F. B.	G. & J. Weir Ltd.
GLICK, G. L.	George Wimpey & Co. Ltd.
GREGORY, M. S.	Sir Alexander Gibb & Partners.
IMLAY, A. W.	General Electric Co. Ltd.
JONES, R. B.	Scott & Wilson, Kirkpatrick & Partners.
MCFARLANE, A.	Imperial Smelting Corpn.
OTTON, L. E.	Dorman, Long & Co. Ltd.
WILSON, O. W.	Dorman, Long & Co. Ltd.
Chile	
BARAHONA, J. R.	High Duty Alloys Ltd.
BURGOS, P. H.	Metropolitan-Vickers Electrical Co. Ltd.
GARCIA-HUIDOBRO, A.	Blackburn & General Aircraft Ltd.
FUENTES, S.	Associated British Machine Tool Makers Ltd.
RUIZ, F. G.	Hartleys (Stoke-on-Trent) Ltd.
Colombia	
CRUZ, E. A.	Mavor & Coulson Ltd.
LEMA, G.	Metropolitan-Vickers
VELASQUEZ, R. D.	Sir William Halcrow & Partners
Cuba	
CONDE, E. F.	Ruston & Hornsby Ltd.
MUNIZ, M. A.	G. & J. Weir Ltd.
TOYOS, R.	Brush Group.
India	
BOSE, C.	British Insulated Callender's Cables Ltd.
GOSH, S.	Metropolitan-Vickers
PANJWANI, N. B.	Coventry Gauge & Tool Co.
SANYAL, A. S.	General Electric Co. Ltd.
Mexico	
CAMACHO, A.	English Steel Corporation
GARCIA, R.	English Steel Corporation
ROLDAN, J. R.	Walmsley's (Bury) Ltd.
Peru	
ARCE, M.	Holman Bros. Ltd.
BEDOYA, E.	Ransomes & Rapier Ltd.
BUSTAMANTE, J.	Donovan H. Lee.
MORALES, F.	Gwynnes Pumps Ltd.
PASTOR, O.	Brush Group Ltd.
PAZ CARIAT, C. A.	Brush Group Ltd.
QUEVEDO, W.	J. & E. Hall Ltd.
RUIZ, H.	Metropolitan-Vickers

The following have also accepted scholars since the scheme was started in 1950.

Alley & Maclellan Ltd.
Babcock & Wilcox Ltd.
Bentley & Jackson Ltd.
Bertrams Ltd.
British Railways
Bruce Peebles & Co. Ltd.
B.S.A. Tools Ltd.
Demolition & Construction Co. Ltd.
Ferranti Ltd.
K. & L. Steelfounders & Engineers Ltd.
Marconi's Wireless Telegraph Co. Ltd.
Mather & Platt Ltd.
McCalls Macalloy Ltd.
J. & H. McLaren Ltd.
Mirrlees, Bickerton & Day Ltd.
Beyer, Peacock & Co.
British Electricity Authority
National Gas & Oil Engine Co. Ltd.
Newton, Chambers & Co. Ltd.
Petters Ltd.
Renold & Coventry Chain Co. Ltd.
Stewart (Duncan) & Co.
Tees Side Bridge & Engineering Works Ltd.
Watson, Laidlaw & Co.
Wiggins Teape & Co. (1919) Ltd.

ANOTHER WIDE-STRIP MILL?

CRUCIAL ISSUE FOR THE IRON AND STEEL INDUSTRY

The tremendous upsurge in the output of motor-cars and consumer durable goods—refrigerators, washing machines and the like—during 1954 has set the British iron and steel industry a most difficult problem. Should it stick to its plans for a gradual increase of sheet-steel output during the next four years in accordance with the pattern of demand that has developed since the war, or should it revise them to take into account a basic change in this pattern?

In the British Iron and Steel Federation's recent statement "Steel in 1955"—some aspects of which are discussed in an article in this issue—the industry states its belief that it will be able to meet industrial requirements in 1957-58, which it estimates at 21 million ingot tons. But—and the but is a large one—the demand for sheet may grow faster than has been anticipated, and the question it has to face therefore is the correct timing of the erection of a new wide-strip rolling mill, which will take at least four years to build and a further two years to reach full output. No attempt is made to argue that such an extension to sheet-making capacity will not be needed one day; on the contrary, the document states "there will come a time . . . when a further large increment of capacity for flat rolled products will be necessary." The decision to erect a new mill cannot, however, be taken lightly, since a modern mill needs to have an output of not less than a million tons of sheet a year and would cost about £100 million to build and would require at least £35 millions for working capital.

Consumer spending has set the course of industrial development during the past year—in overseas markets as well as in this country. The welfare state, which is well established in countries such as Australia, New Zealand, Canada, Sweden, Belgium and most other countries in Western Europe, appears to be the spearhead of a higher standard of living. Basic necessities, such as food and clothing, are adequately covered, and in Britain at any rate the standard of living is rising fast beyond the point at which eating more or being better clad is no longer a need acutely felt by the general public. Available statistics of the output of various industrial groups bear this out: the lowest increases in output during 1954 were recorded for "food, drink and tobacco," "textiles" and "clothing." The change in consumer tastes—in the economic jargon, the consumer's scales of preference—was revealed quite suddenly, as soon as the Government relaxed restrictions on hire purchase sufficiently to bring major items of consumer durable goods within the weekly means of a vast section of the community. For example, the number of used cars sold by hire purchase has risen from 90,587 in 1952 to 253,463 last year, and that of new cars from 14,048 to 52,794.

Is this a passing phase, or is it the beginning of a course followed by the U.S. consumer some 25 years ago which led to a car for every three citizens and to mechanised housework and homes filled with every kind of sheet-steel-consuming appliance? There is much to suggest that it is the latter, and provided real wages continue to rise and that inflation can be avoided, there appears to be no reason why it should not continue. An important aspect of this development is its snowball effect: larger demand for cars, washing machines, etc., leads to greater production of standard articles at lower real cost, to higher wages which in turn attract the only labour reserve available—women, who buy mechanical appliances to enable themselves to go to work, and so on.

What, then, is the doubt which restrains the steel industry from going ahead with a new wide strip mill? In part, probably, its unwillingness to accept that so radical a change in consumer expenditure has taken place until it is established beyond doubt. It has in any case, relatively little to lose by trailing the demand for its products. The main reason, however, is without doubt its unwillingness to accept the export estimates of the motor industry and, by implication, that of the manufacturers of refrigerators, washing machines, dish washers, clothes dryers, etc. Since these items are a most important part of our exports—car exports in January to November, 1954, were valued at over £108 millions—any fall in exports, or failure to increase them in proportion to output, would threaten the whole basis of our economy.

The exports of cars during the first 11 months of last year constituted 48·5 per cent. of the total output, compared with 52·0 per cent. in the corresponding period of 1953. Of the 333,800 cars exported, over 79 per cent. went to ten leading markets (73 per cent. in 1953 and 52 per cent. in 1952). The dependence on Australia (24·4 per cent.), New Zealand (10·5 per cent.) and Sweden (11·3 per cent.) was such that any serious disturbance in the trade of these countries, as threatens in that of Australia, could obviously affect the industry's total exports.

The conclusion must be that the demand for cars is expanding fast in all principal markets, but that British exports are on a dangerously narrow base. Competition from Germany is certain to increase during the current year—General Motors, for example, are expanding output at their Opel plant to 1,000 vehicles a day, and local production in leading markets is growing, particularly in Australia. The dependence of Australia on wool and food exports—at a time when U.K. expenditure on clothing and food is almost static—is unfortunate. It would seem, however, that provided a high standard of living is maintained throughout the Western World and rising standards in the East, primary producers should earn well and be in a position to buy more from us. The vast scale of output planned in car factories suggests that costs will be reduced—at any rate in real terms. Finally, the decision of motor-car manufacturers to invest as much as £200 millions in production facilities shows remarkable confidence in the realism of their targets: 1½ million vehicles—over a million cars—by 1960, half of which will be exported. There is, however, ample room for doubt on the part of the outsider, even if he is as close to the industry as the steel companies undoubtedly are. These estimates are made independently by each company, and it is more than likely that they are well seasoned with optimism regarding the ability of each to sell successfully in competition with the others.

Several other factors will doubtless influence the steel industry when a decision is made concerning the erection of a new wide-strip mill. Sheet production is expected to rise as much as planned car output during the next four years—15 per cent. this year, averaging about 9 per cent. per annum over the period—and the output of wide sheet could be raised if the mills supplied less plate and less medium and narrow sheet. The industry may expect a fall in shipbuilding output, although this is most unlikely during the next four to six years, provided the level of world trade continues to rise. Everything, or almost everything, will depend on export performance. The first half of this year should provide most of the guidance the industry may justifiably require before it takes the plunge. If, indeed, it has not already taken the decision.

*Deliveries of Sheets, Coated and Uncoated, by Consuming Industries during the first 11 months of 1954.**

	Tons
Iron and steel	53,779
Constructional engineering	31,137
Electrical machinery and apparatus	151,983
Manufacture and repair of motor vehicles, etc.	448,575
Hollow-ware	131,569
Metal furniture, etc.	89,901
Stockholding merchants	295,735
Other users	270,360
Exports by producers	334,500
Total	1,807,539

* Source: B.I.S.F. *Bulletin*, January to November, 1954.

Obituary

MR. WILLIAM OGILVIE

Machine Tool Design

It is with regret that we record the sudden death of Mr. William Ogilvie, which occurred at his home in Worthing, Sussex, on January 3. Mr. Ogilvie who was born on November 22, 1890, was technical director of B.S.A. Tools Limited, Mackadown-lane, Kitts Green, Birmingham, 33. He was educated at Monoux Grammar school, Walthamstow and Parmitters School, Cambridge Heath, London, and, in 1907, entered upon an apprenticeshid five years at the British Thomson-Houston Company's works at Rugby. From 1913 to 1919, he was engaged with the Daimler Company, at Coventry, first on jig and tool design and layout and subsequently as assistant to the works engineer. In this capacity Mr. Ogilvie was responsible for the purchase of machine and small tools and their maintenance. His long association with B.S.A. Tools Limited, Birmingham, commenced in 1920, when he was appointed chief draughtsman, responsible to the managing director for the design of jigs and tools and special machines. In 1927, Mr. Ogilvie was made chief engineer of the firm and among other work was personally responsible for centreless grinding and bar automatic machines. He was appointed technical director, B.S.A. Tools, Limited, in 1947.

Mr. Ogilvie was elected a member of the Institution of Mechanical Engineers in 1945, and was also a member of the Institution of Production Engineers. He served on the Machine Tool Trades Association standards-policy committee and also on various British Standards Institution Committees, representing either the Machine Tool Trades Association or the Institution of Production Engineers.

* * *

MR. R. O. HERFORD, O.B.E.

Precision Mass Production of Chains

We regret to record the death of Mr. R. O. Herford, O.B.E., which occurred on January 2, at Buenos Aires, during a visit to the overseas agents of Renold Chains Limited. He was a member of the board of this firm and a former managing director.

Robert Osler Herford was born at Stand, near Manchester, in 1888. In 1909, he joined Hans Renold Limited as an apprentice, and was appointed works director in 1919. On the merger of Hans Renold Limited, The Coventry Chain Company Limited, and Brompton Brothers Limited, in 1931, he became general works manager. In 1944 he was appointed managing director, and retained this office until his retirement in 1953. During the second World War he was "lent" by the Company in 1941 to the Ministry of Supply, in which he acted as Controller of Inspection (Administration) until 1944. In 1945 he was awarded the Order of the British Empire for his services during this period.

During the 46 years that Mr. Herford was with the Renold Company, he was closely concerned with tooling and the problems of precision mass production, and was largely responsible for the high standard of quality, uniformity and accuracy achieved.

He served at one time on the North West Regional Council and on the Overseas Trade Policy Committee of the Federation of British Industries, and as the Machine Tool Trades Association representative of the F.B.I. Defence Programme Sub-Committee, of which he was chairman dealing with Government inspection matters.

* * *

We also regret to record the deaths of:

Mr. HOWARD FOULDS, F.C.I.S., on December 23, 1954, in his 86th year. He was secretary at Faraday House during the first decade of the century and afterwards became secretary of the Birmingham Corporation Electric Supply Department. In 1918, he was appointed to the secretaryship of Callender's Cable and Construction Co. Ltd., and held this position until 1945, when he retired on the amalgamation of the company with British Insulated Cables Ltd., to form the present British Insulated Callender's Cables Limited.

MR. JAMES HUGILL, of Thornaby-on-Tees, on December 30, 1954, at the age of 60. Mr. Hugill was founder and proprietor of the Hugill Forge and Engineering Works, Church-road, Stockton-on-Tees.

CAPTAIN JAMES FRANK WILLIAM MUDFORD, R.N.(ret.), at Sadberge, Darlington, Durham, on December 31, 1954, at the age of 56. Captain Mudford was secretary of the British Iron and Steel Federation Northern Area Training Committee

MAURICE EDWARD ANDERSON, on December, 25, 1954, at the age of 48. Mr. Anderson was one of the senior members of the technical staff of J. & E. Hall Ltd., Dartford Ironworks, Dartford, Kent, and was an active member of the Institute of Refrigeration.

* * *

PERSONAL

The Council of the Institution of Electrical Engineers have elected Mr. J. R. Beard, C.B.E., M.Sc., to honorary membership of the Institution, and have made the 33rd award of the Faraday Medal to SIR JOHN COCKCROFT, K.C.B., C.B.E., Ph.D., F.R.S.

SIR HUGH WARREN, D.Sc., M.Sc. (Eng.), M.I.E.E., M.I.Mech.E., F.Inst.P., managing director of Associated Electrical Industries, Ltd., has retired as from December 31, 1954.

SIR H. REGINALD KERR, K.B.E., C.B., M.C., divisional manager, Midland Division, British Road Services, since September, 1948, has been made general manager, British Transport Waterways, by the British Transport Commission.

DR. R. J. SARJANT, O.B.E., F.I.M., has been appointed director of research, the British Steel Castings Research Association, Broomgrove Lodge, Sheffield, 10. DR. A. H. SULLY, M.Sc., F.Inst.P., F.I.M., has been appointed associate director of research. Dr. Sully takes up his new appointment in March.

THE RT. HON. THOMAS JOHNSTON, C.H., LL.D., chairman of the North of Scotland Hydro-Electric Board, and SIR HUGH MACKENZIE, C.B.E., deputy chairman of the Board, whose terms of office expired on December 31, 1954, have been re-appointed for a further period by the Secretary of State for Scotland. Three of the members of the Board have also been re-appointed for a further term, namely, MR. WILLIAM LEONARD, MR. G. R. MCINTOSH, C.B.E., and MR. A. I. MACKENZIE, B.A.

MR. C. C. WALKER, C.B.E., A.M.I.C.E., Hon. F.R.Ae.S., has retired from the board of the DE HAVILLAND AIRCRAFT CO. LTD., as from December 31, 1954.

MR. LOUIS ARMAND, director-general of the Société Nationale des Chemins de Fer Français, with the approval of the French Government, has agreed to carry out an inquiry, on behalf of O.E.E.C., the Organisation for European Economic Co-operation, on current energy problems in Europe.

PROFESSOR ARNOLD TUSTIN, M.Sc., M.I.E.E., Professor of Electrical Engineering, Birmingham University, since 1947, has been appointed to the University of London Chair of Heavy Electrical Engineering, tenable at the Imperial College of Science and Technology, South Kensington, S.W.7.

MR. WILLIAM SINCLAIR, director of the Dunlop Rubber (Scotland) Co. Ltd., has received a C.B.E., in the New Year Honours, for political and public services in Glasgow.

Kennedy and Donkin, 12, Caxton-street, London, S.W.1, have appointed three senior members of their staff to be consultants to the firm as from January 1, namely, MR. J. NORTH, B.A., M.I.C.E., MR. M. V. RATCLIFFE, B.Sc. (Eng.), M.I.E.E., and MR. F. J. HUTCHINSON, M.Eng., M.I.Mech.E., M.I.E.E.

MR. A. DE M. BROWNE, B.Sc., A.R.C.Sc.I., managing director of the Hackbridge and Hewittic Electric Co. Ltd., Walton-on-Thames, Surrey, has been appointed chairman of the company.

MR. H. R. COX, A.M.I.Mech.E., M.I.Loco.E., has been appointed general assistant to the Motive Power Superintendent, Swindon, British Railways, Western Region.

MR. E. B. ROGERS, manager of the service department of the valve division of Mullard Ltd., Century House, Shaftesbury-avenue, London, W.C.2, retired on December 31, 1954. Mr. Rogers, who has been with the department for 28 years, will be succeeded by MR. F. E. DEBENHAM, who has been deputy manager for the past three years.

MR. A. M. DANIELS, senior engineer and ship surveyor in the Newcastle-upon-Tyne Marine Survey Office of the Ministry of Transport and Civil Aviation, has been appointed principal officer of the East of England District, Hull, with effect from January 17, in succession to MR. R. J. SHEPHERD, who retired in December.

MR. T. ALLEN has been appointed to the board of G.W.B. Furnaces Ltd. and will be the administrative director in charge at Dibdale Works, Dudley, Worcestershire. MR. A. V. FRANCIS has been made chief engineer in charge of furnace design and sales.

MR. DAVID LEIGHTON DAVIES, B.Sc., has been appointed chief electronic engineer, Winston Electronics, Ltd., Park-road, Hampton Hill, Middlesex.

MR. H. LUNDY, B.Sc., has joined the Timber Fireproofing Co. Ltd., London, Market Bosworth, and Glasgow, and has taken charge of the technical service department, Oxylene Boram division.

MR. J. D. KNOX has been appointed to take charge of the London office of Simon-Carves Ltd., power-plant department, at Simon House, 6, Stratton-street, W.1, as from January 1.

MR. H. W. BARNETT, London manager for the Butterley Co., Ltd., and other concerns, resigned on December 31, 1954, after 18 years of service, to start his own advertising business. His temporary address is Room 15, Clarence House, Arthur-street, London, E.C.4.

MR. M. W. ELDRIDGE, A.M.I.Mech.E., has been appointed representative of the Society of Motor Manufacturers and Traders, 148, Piccadilly, London, W.1, in India, Pakistan, Burma and Ceylon, in the place of MR. A. E. L. COLLINS, who has resigned to join Ashok Motors Ltd. in India.

MR. H. J. HAON has been appointed manager of the European office of E. I. du Pont de Nemours & Co., Wilmington 98, Delaware, U.S.A., at Bush House, Aldwych, London, W.C.2, in succession to MR. S. R. STAGER, JR., who is returning to the company's head office.

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COMMERCIAL

ALBRIGHT AND WILSON LTD., 49, Park-lane, London, W.1, have announced that, under arrangements recently completed, the ownership of their silicone manufacturing plant at Barry, South Wales, has been transferred to MIDLAND SILICONES LTD., the company established to distribute these products. Albright and Wilson are majority shareholders in Midland Silicones Ltd., the balance of the shares being held by DOW CORNING CORPORATION OF AMERICA.

CROFTS ENGINEERS (HOLDINGS) LTD., have purchased the whole of the share capital of CARTER GEARS LTD., Thornbury-road, Bradford. The firm will be carried on as a wholly-owned subsidiary company in the Crofts Group under the chairmanship of SIR ARTHUR CROFT. MR. MAURICE CARTER, B.Sc., A.M.I.Mech.E., will continue as managing director of the company.

As from January 1, the manufacture and sale of moulding powders, synthetic resins and other plastic raw materials, hitherto carried out by BRITISH INDUSTRIAL PLASTICS LTD., at Oldbury, near Birmingham, have been transferred to a wholly-owned subsidiary company, B.I.P. CHEMICALS LTD., the offices of which are also at Popes-lane, Oldbury, near Birmingham.

The name of BLICK ENGINEERING LTD., Bedesway, Bede Trading Estate, Jarrow, Co. Durham, has been changed to BLICKVAC ENGINEERING LTD., as from January 3. The board now consists of MR. O. MOORE M.A.(Cantab.), MR. R. A. PEARSON, M.A.(Cantab.), MR. J. TODD, A.M.I.E.E., and MR. G. WALL, B.E.M.

G. W. B. FURNACES LTD., announce that owing to the continued expansion of business, the firm's head office, including the accounting section, will be transferred to Dibdale Works, Dudley, Worcestershire, on February 1, next.

The office of the SOCIETY OF MOTOR MANUFACTURERS AND TRADERS in North America (the United States and Canada) will be moving to a new address on February 1, namely: SIR WILLIAM WELSH, the Society of Manufacturers and Traders, 1145, 19th Street, Northwest, Washington, 6, District of Columbia, U.S.A.

NEW GENERATING PLANT IN 1954

British Electricity Authority Add 1,430 *MW in* 1954

The accompanying table, which has been prepared by the Chief Engineer's Department of the British Electricity Authority, shows the plant which was added to the public power stations in this country in 1954. This represents an additional output capacity of 1,431 MW, compared with 1,413 MW in 1953.

As will be seen, the additional plant comprised 29 turbo-alternators with an aggregate installed capacity of 1,405 MW and 50 boilers having an aggregate evaporative capacity of 16,220,000 lb. per hour. In addition, 17 Diesel-engined generators with an installed capacity of nearly 26 MW were installed in 9 stations. The new stations in which plant was installed for the first time are shown in large type.

It is pointed out that the capacity of the new plant installed in each of the past two years was adversely affected during the early stage of construction by the shortage of steel arising from the Korean war. Nevertheless, the capacity of the new plant installed during 1954 closely approximated to the level of commissioning sanctioned by the Government for that year, namely, 1,450 MW.

In the circumstances, this reflects great credit on the Authority's construction staff, the plant manufacturers and the civil engineering and building contractors. As steel shortage has now been largely overcome, it is expected that there will be a further increase in the amount of new plant installed in 1955.

* * *

CONTRACTS

Power-Station Equipment. During December, 1954, contracts have been placed by the British Electricity Authority for power-station equipment amounting, in the aggregate, to £1,344,900. The principal contracts include: For Goldington power station, Bedford: three cooling towers, with FILM COOLING TOWERS (1925) LTD., and 11-kV and lower-voltage cables and accessories, with MALCOLM AND ALLEN LTD. For Nottingham power station: one 30-MVA interbus transformer and the rewinding of two existing 30-MVA transformers, with HACKBRIDGE AND HEWITTIC ELECTRIC CO. LTD. For Willington "A" power station, near Derby: one 106-MVA 275-kV generator transformer, with the ENGLISH ELECTRIC CO. LTD. For Ferrybridge "B" power station, Yorkshire: structural steelwork, with UNITED STEEL STRUCTURAL CO., LTD. For Barony power station, Ayr: superstructures for the main and other buildings, with JOHN LAING & SON, LTD. For Dalmarnock power station, Glasgow: high-pressure pipework and valves, with STEWARTS AND LLOYDS LTD.

Switchgear. An order has been received by the BRITISH THOMSON-HOUSTON CO., LTD., Rugby, for six 230-kV, 7,500-MVA, type-JW 419 oil circuit-breakers for the British Columbia Electric Company's power-transmission system.

Prestressed-Concrete Bridge. Work is about to commence on the prestressed-concrete bridge over the River Trent at Clifton, Nottingham. The structure will carry a 22-ft. carriageway, a 9-ft. cycle track and a 6-ft. footpath, so forming half of the dual-carriageway bridge proposed for the site. The bridge comprises a main 275-ft. span (including a 100-ft. suspended span), two anchor spans of 125 ft., and viaducts over low-lying grounds; the total continuous length of the bridge and southern viaducts is 795 ft. Lee-McCall and Magnel-Blaton systems for prestressing are to be employed. The main contractors are JAMES MILLER AND PARTNER, 7 Suffolk-street, London, S.W.1; the consultants, R. Travers Morgan and Partners, 11 Victoria-street, Westminster, London, S.W.1.

Steam Turbo-generator Sets. The Instituto Nacional de Industria, Spain, has ordered power plant having a total output of 142,500 kW. for installation on the south coast of Spain, in Majorca, and in Spanish Morocco. The contract, the value of which approaches £2,000,000, has been awarded to the METROPOLITAN-VICKERS ELECTRICAL CO. LTD., Trafford Park, Manchester, 17. Six steam turbo-generator sets are to be supplied, together with condensing, feed-heating and evaporating plant. Four of the sets are each rated at 30,000 kW, and two are for Cadiz, one for Almeira and one for Malaga; one set is rated at 15,000 kW and is for Palma de Mallorca, and the sixth, of 7,500 kW, for Ceuta in Morocco. Single-cylinder turbines will be used throughout, the 30,000-kW machines operate with inlet steam at 850 lb. per square inch gauge and 900 deg. F., with cooling water at 80 deg. F., while for the smaller turbines the figures are 600 lb. per square inch, and 825 deg. and 68 deg. F. The four larger generators, each rated at 37,500 kVA, are hydrogen-cooled and will generate at 11,800 volts. The 15,000-kW and 7,500-kW machines are air-cooled.

Power Station*	B.E.A. Division	Turbo-Generator Plant			Boiler Plant			High-Pressure Pipework
		Installed Capacity		Maker	Capacity		Maker	Maker
		No.	Capacity, each, MW.		No.	lb. per hr. each		
Steam Plant								
ACTON LANE "B"	London	1	30	Richardsons, Westgarth	2	240,000	Mitchell	Aiton
BARKING "C"	London	1	75	British Thomson-Houston	2	405,000	Babcock & Wilcox	Aiton
BATTERSEA "B"	London	—	—	—	1	425,000	Babcock & Wilcox	Aiton
BLACKBURN	North West, Merseyside and N. Wales	1	40	English Electric	2	150,000	Simon-Carves	Babcock & Wilcox
BOLD "A"	North West, Merseyside and N. Wales	1	30	Metropolitan-Vickers	1	300,000	Yarrow	Aiton
BRAEHEAD	South West Scotland	—	—	—	1	300,000	Babcock & Wilcox	Babcock & Wilcox
BRIGHTON "B"	South Eastern	—	—	—	1	320,000	Babcock & Wilcox	C. A. Parsons
BRUNSWICK WHARF	London	1	52·5	Metropolitan-Vickers	4	320,000	Clarke, Chapman	C. A. Parsons
CARMARTHEN BAY	South Wales	1	60	Metropolitan-Vickers	2	240,000	Babcock & Wilcox	Stewarts and Lloyds
CARRINGTON	North West, Merseyside and N. Wales	1	60	Metropolitan-Vickers	1	360,000	Babcock & Wilcox	Stewarts and Lloyds
CHADDERTON	North West, Merseyside and N. Wales	1	60	Metropolitan-Vickers	3	360,000	Simon-Carves	Stewarts and Lloyds
CLIFF QUAY	Eastern	—	—	—	1	365,000	Babcock & Wilcox	Aiton
CONNAHS QUAY	North West, Merseyside and N. Wales	1	30	C. A. Parsons	1	300,000	International Combustion	J. Thompson
DEPTFORD EAST	London	1	52·5	Metropolitan-Vickers	1	250,000	Foster Wheeler	J. Thompson
DONCASTER	Yorkshire	1	30	General Electric	1	180,000	Mitchell	Aiton
DRAKELOW "A"	E. Midlands/Midlands	1	60	English Electric	1	515,000	International Combustion	Aiton
EAST YELLAND	S. Western	1	30	C. A. Parsons	2	180,000	J. Thompson	C. A. Parsons
HACKNEY "B"	London	1	30	C. A. Parsons	1	300,000	Simon-Carves	C. A. Parsons
HUDDERSFIELD	Yorkshire	—	—	—	1	180,000	Bennis	C. A. Parsons
INCE	North West, Merseyside and N. Wales	1	60	General Electric	1	550,000	Internatonal Combustion	Babcock & Wilcox
KEADBY	Yorkshire	2	60	C. A. Parsons	2	550,000	Stirling Boiler/B. & W.	C. A. Parsons
LITTLEBROOK "C"	South Eastern	—	—	—	1	360,000	International Combustion	C. A. Parsons
NECHELLS "B"	Midlands	—	—	—	2	230,000	International Combustion	Stewarts and Lloyds
PORTOBELLO	South East Scotland	1	60	Richardsons, Westgarth	1	540,000	International Combustion	Aiton
ROOSECOTE	North West, Merseyside and N. Wales	2	30	Metropolitan-Vickers	2	300,000	Yarrow	Aiton
SKELTON GRANGE "A"	Yorkshire	2	60	C. A. Parsons	1	550,000	International Combustion	Aiton
SOUTHPORT	North West, Merseyside and N. Wales	—	—	—	1	85,000	Yarrow	Stewarts and Lloyds
STAYTHORPE "A"	East Midlands	—	—	—	1	240,000	Babcock & Wilcox	Babcock & Wilcox
STOURPORT "B"	Midlands	1	60	English Electric	1	515,000	International Combustion	Aiton
STELLA SOUTH	North Eastern	1	60	C. A. Parsons	1	550,000	Clarke, Chapman	C. A. Parsons
THORNHILL	Yorkshire	1	45	English Electric	1	200,000	Mitchell	Stewarts and Lloyds
USKMOUTH "A"	South Wales	2	60	General Electric	5	360,000	Babcock & Wilcox	Aiton
WALLASEY	North West, Merseyside and N. Wales	—	—	—	1	85,000	Yarrow	Stewarts and Lloyds
WALSALL	Midlands	2	30	British Thomson-Houston	—	—	—	Aiton
Totals: 34 stations		29	1,405		50	16,220,000		
Diesel Plant								
ALDERLEY EDGE	North West, Merseyside and N. Wales	1	2	Mirrlees, Bickerton & Day				
ASHFORD "B"	South Eastern	2	2	Mirrlees, Bickerton & Day				
BARUGH	Yorkshire	2	2	Mirrlees, Bickerton & Day				
BLACKPOOL	North West, Merseyside and N. Wales	5	1·280	Harland & Wolff				
BUXTON	North West, Merseyside and N. Wales	2	2	Mirrlees, Bickerton & Day				
CLACTON	Eastern	1	0·950	English Electric				
HAVERFORDWEST	S. Wales	2	1·220	Crossley Bros				
NEWBURY	Southern	1	1·040	Ruston & Hornsby				
SOUTHEND	Eastern	1	0·950	English Electric				
Totals: 9 stations		17	25·78					

* The names in large type are those of new stations, in which plant was commissioned for the first time in 1954. The others are existing stations to which extensions have been made.

THE ANNULAR SAIL*

By F. C. Johansen, D.SC.

The torque, or turning effort, due to an element of area of a windmill sail is equal to the product of the tangential component of the wind force on the element multiplied by its radial distance from the axis of rotation. The wind force is approximately proportional to the square of the speed of the wind relative to that of the elemental area of sail; and since in general the speed of the natural wind increases with height above ground level, the average turning force during one revolution of an elemental area increases with the radius at which the element revolves. Hence, from the standpoints both of force and radius arm, the turning effort of a windmill sail is increased by concentrating as much as practicable of the sail area at the greatest possible distance from the windshaft.

In the case of the annular sail illustrated below, this was done by providing a large total area of sail in the form of an annulus comprising 120 blades spaced as closely together as was feasible without causing undue aerodynamic interference (with consequent loss of efficiency) between adjacent blades. At the extreme inner and outer ends of each blade the wind force is necessarily zero, and has a maximum value intermediate between the ends. From this standpoint alone, the individual blades must not be unduly short radially; hence, an aspect ratio (i.e., span ÷ chord) of about six, such as was often given to rectangular aircraft wings forty years ago, represents a good compromise. The individual blades of the annular sail seem to have had about these proportions, and to have been circumferentially spaced about one blade-chord apart.

Another point is that if a sail has a big radial length, the pitch (i.e., the angle between the plane of the surface of the sail and the plane of the circle in which it rotates) should vary from the windshaft to the tip to take account of the increase of circumferential speed as radius increases. How far this was achievable with conventional mill sails I do not know, but I imagine it might be so difficult, structurally, as often to be neglected, with consequent loss of aerodynamic efficiency. In the case of the annular sail, however, all the blades were short relatively to the mean radius of the annulus in which they were mounted. Even though, therefore, the pitch of the blades was perhaps constant along their radial length, the consequent loss of efficiency would be small.

The purpose of a windmill is to extract turning power from the wind, and its sails should, therefore, be set at such an angle to the wind direction as to produce the maximum tangential force irrespective of what the associated axial force, or thrust, may be. This angle may need to be small, so that the blade is only slightly inclined to the wind. Now, if a mill has only four sails, each of them must be wide to provide enough area to give the required total turning effort; but it is hardly possible to set wide sails at a small angle to the wind, because they would have to project too far upstream to prevent their trailing edges from touching the body of the mill structure. If the sails are very "flat" to the wind, the only way in which they can be efficient is for them to rotate at higher speeds than mechanical considerations of mill construction will permit. Hence, the big sails of a four-sailed mill, "flat" to the wind and rotating slowly, are not efficient and suffer a large thrust in the wind direction which is wasted in friction at the thrust bearing.

The narrow blades of the annular sail, on the other hand, could be inclined at the optimum angle to the wind without projecting inconveniently beyond the plane of the annulus, and could, therefore, work efficiently with small loss from axial friction.

A final feature of the annular sail which may have contributed to its good performance is the uniformity of turning power due to its having a large number of blades equally spaced around an annulus. The interference in wind flow due to the mill body downstream of the annulus continuously affects about one-sixth of the total sail area, and the turning power should, therefore, have been very constant in a steady wind. With a four-sailed mill, on the contrary, the interference of the mill body causes a momentary diminution of turning effort four times per revolution every time a sail passes in front of the body.

To summarise, I consider that the good performance of the annular sail was due to a large number of blades or vanes which could be shaped and set to the wind so as to have good aerodynamic efficiency, and all of them being at the greatest practicable radial distance from the windshaft. Uniformity of turning effort was an additional advantage.

* Appendix A of the recently published book *The English Windmill* (reviewed on this page). Reprinted here by kind permission of the publishers and of the authors of the book and the appendix.

Boxford Mill, Suffolk, built 1841, fitted with an annular sail 1861, demolished 1901.

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Book Reviews

WINDMILLS AND MILLWRIGHTS

The English Windmill. By REX WAILES. *Routledge and Kegan Paul, Limited, Broadway House, 68-74 Carter-lane, London, E.C.4.* (35*s.* net.)

The economic changes resulting from two World Wars have dealt hardly with the only two means by which Man has harnessed the force of the wind to his industrial purposes. The first World War effectively put an end to the long reign of the sailing ship, and the second greatly accelerated, if it did not actually initiate, the disappearance of the windmill from the British countryside, and is having the same effect, in increasing degree, in the Netherlands and other countries where once this form of prime mover was a characteristic feature. Many writers have contributed to the literature of the sailing ship, but fewer have been devotees of the windmill and none, we believe, has brought to its study quite the same combination of thoroughness and technical knowledge as has the author of this book. For Mr. Wailes (though his title-page modestly omits to state the facts) is not only a Fellow of the Society of Antiquaries, but is also a member of the Institution of Mechanical Engineers and the managing director of a firm of engineers and millwrights who will attain their centenary in 1955. The 31 years' research into the subject which he admits in his preface is not, therefore, merely the interested inquiry of a *dilettante*, but the practical investigation of an experienced engineer; and one who, incidentally, has supervised the repair and restoration of a considerable proportion of the few windmills which still remain in working order. Thus his book is authoritative to an extent that cannot be claimed for many others.

The book is divided into three parts, dealing, respectively, with "The Mills," "The Machinery," and "The Men." The first part contains separate chapters which describe generally the post mill (the oldest type), the smock mill and the tower mill, and then, in considerable detail, the mills still remaining at Saxstead Green in East Suffolk, Cranbrook in Kent, and Sibsey in Lincolnshire, the Norfolk fen-drainage mills, and miscellaneous mills in various parts of the country. Part Two describes in detail the different forms of sails, caps, windshafts, brake wheels and gearing, the stones and their maintenance and adjustment, and such auxiliary items as sack hoists, bolters, etc. The third part is, to some extent, a biographical record of typical millers and millwrights of the old school, now fast disappearing, but contains also a selection of anecdotes, historical notes, records of the not inconsiderable feat of moving mills bodily across country, inscriptions and epitaphs, and numerous other notes which make of it a most varied and entertaining anthology. There are four appendixes, those on the annular sail (reprinted on this page) and on stone dressing being of particular technical interest; and also a glossary, a bibliography, maps showing the sites of more than 300 mills which are mentioned in the text, and a good index.

The illustrations are planned on a liberal scale, and include many reproductions of photographs and old prints, and a number of line drawings. These last are somewhat uneven in quality, however, and are open to the criticism that some of them occupy much more space than their contribution to the book warrants; it is difficult to see, for instance, why two full pages should be devoted to two drawings of Sibsey Mill, made from standpoints less than 90 deg. apart when one would have sufficed. Mention

may be made, also, of a strange error on page 177, where the name of Nelson's flagship Foudroyant is rendered as " Fonderait." These, however, are minor defects in a book which not only possesses popular appeal, but is assured of a permanent place in reference libraries as a repository of technical detail and curious lore regarding a branch of craftsmanship that was once of major economic importance, but now is all but extinct.

THE WRIGHT BROTHERS

The Papers of Wilbur and Orville Wright. Edited by MARVIN W. MCFARLAND. Two vols., 1899-1905 and 1906-1948. *McGraw-Hill Book Company, Incorporated, 330 West 42nd-street, New York 36, N.Y., U.S.A.* (25 dols the set); and *McGraw-Hill Publishing Company, Limited, 95 Farringdon-street, London, E.C.4* (£10 the set).

The jubilee of the first free flight by a power-driven piloted aircraft, which was made by the Wright brothers on December 17, 1903, inevitably inspired the publication of a number of books about these outstanding, if hitherto somewhat enigmatic, pioneers of aviation, but none can approach in importance this remarkable collection of what the editor justly terms " basic aeronautical documents." This they certainly are, but they are not less important as revelations of the characters of two men who were, perhaps, less adequately appreciated as men, by the public at large, than most of those whose activities have attracted a corresponding popular interest. It would probably be true to say that the average man possesses a truer mental picture of James Watt than he does of either Wilbur or Orville Wright, though it would be difficult to decide whether Watt or the Wrights more profoundly affected the present-day average man's life.

The keynote of the book is struck by the quotation from Wilbur Wright which precedes the editor's introduction. It is dated April 3, 1912—less than two months before his death from typhoid fever—and epitomises perfectly the relation between the brothers. " From the time we were little children," says Wilbur, " my brother Orville and myself lived together, played together, worked together and, in fact, thought together. We usually owned all of our toys in common, talked over our thoughts and aspirations, so that nearly everything that was done in our lives has been the result of conversations, suggestions and discussions between us." It might easily have happened that such a close association might have hampered rather than helped the work of the historian by rendering seemingly unnecessary the recording of day-to-day progress; but happily the Wrights were methodical recorders, and not only so, but were on terms of equally close confidence with their father, Bishop Milton Wright, and their sister, Kathleen, to whom they wrote extensively, and who preserved the correspondence. Bishop Wright, like his sons, also kept a diary; thus it comes about that there accumulated a remarkably large and detailed mass of material.

Even so, it might not have survived, had it not been that, by the time of Wilbur's death, the importance of their pioneering work had become self-evident. Orville therefore carefully preserved the papers, though he allowed no-one to examine them during his lifetime and did not himself make any definite arrangements for their eventual custody. That duty fell to his executors, Mr. Harold S. Miller, of Dayton, Ohio, and Mr. Harold W. Steeper, of Lawrence, Kansas, who, as Mr. McFarland truly says, " merit the highest praise for the wise and generous decisions which have made the Wright aeroplane and the Wright papers the heritage of the American people." The aeroplane, after a long sojourn in the Science Museum at South Kensington, is now in the National Air Museum at the Smithsonian Institution, Washington; and the Wright papers are in the Library of Congress, only a short distance away from it. The editing of the papers was made possible by the generous financial assistance afforded by Oberlin College, of which Kathleen Wright had been a trustee and to which Orville had left a considerable sum in his will. Oberlin was the first academic centre to recognise the work of the Wright brothers by conferring honorary degrees upon them, and had always followed their progress with interest.

To attempt to summarise in a review the immense mass of material that this book contains in its almost 1,300 pages would be to undertake an impossible task. The period covered starts in 1899, when Wilbur, then 32 years of age, wrote to the Smithsonian Institution for information on human flight because, he said, " I am about to begin a systematic study of the subject in preparation for practical work to which I expect to devote what time I can spare from my regular business," that of building bicycles. It extends to January 24, 1948, when Orville wrote to the General Electric Company regarding a 10-h.p. motor. He died six days later. The brothers' diaries begin in 1900, when their investigations were still in the preliminary stage of what they termed " scientific kite flying "; but before that year was out they had begun to realise something of the possibilities that lay ahead. One of the most interesting items in the book is the extract from a letter that Wilbur wrote to his father on September 3, 1900: " It is my belief that flight is possible and while I am taking up the investigation for pleasure rather than profit, I think there is a slight possibility of achieving fame and fortune from it. It is almost the only great problem which has not been pursued by a multitude of investigators, and therefore carried to a point where further progress is very difficult. I am certain I can reach a point much in advance of any previous workers in this field even if complete success is not attained at present." The editor comments that, evidently, " the Wrights were hardly so naïve . . . as some have supposed."

They were greatly assisted, in clarifying their ideas and developing their methods, by the close contact which they maintained with the veteran Octave Chanute, with whom they exchanged several hundred letters in the ten years from May, 1900, to 1910, when Chanute died. The material contents of that correspondence are contained in this book and are by no means its least interesting and revealing feature; there was a difference of 45 years in their ages—Chanute was born in 1832—but the letters are those of two eager intellects collaborating in a common aim, with no hint of the difference in status between " him that girdeth on his harness " and " he that putteth it off." It was an association that must have influenced greatly the development of the Wrights' early aeroplanes—and it may be remarked, in passing, that " aeroplane " was the designation that they preferred, and that they used to the end of their respective lives.

It is tempting to quote, for this is a book which may be dipped into almost anywhere with the certainty of landing on some interesting detail. It portrays the brothers as few but their most intimate friends can have known them to be. For too long they have lain under the imputations of their contemporary photographs—usually Press snapshots; Wilbur, hawk-faced and (apparently) always grimly taciturn, and Orville, it might be thought, not so much given to original ideas or the display of initiative, but an able lieutenant of the utmost dependability. The letters show them in a different light; indeed, in many different lights, not least as the possessors of a native humour that, in a Scot, would be described as " pawky."

While Wilbur lived, the correspondence (as distinct from the diaries and other interpolated papers) was largely between members of the Wright family and their immediate associates. After Wilbur's death, and as Orville found himself involved in a regrettable amount of litigation, the range of contacts became more widely spread, and, copious though the editor's footnotes are, it is a little difficult at times to keep track of the correspondents' many identities. Inevitably, too, some letters raise points which have to be left unanswered, either because they never were answered or because the answer is not contained among the surviving papers. We must confess, however, that it would be interesting to know what opinion Orville did eventually reach " in regard to the ENGINEERING article on ' The Center of Pressure Travel,' " to which he referred in a letter of October 2, 1912. The article was, in fact, a paper on " The Distribution of Pressure on Inclined Aerocurves," presented before Section G of the British Association in that year by Dr. A. P. Thurston on the basis of investigations carried out by him at what was then East London College; for it deserves to be remembered that the early research work on aviation was not all done in the United States or even in France, as the Wrights themselves were well enough aware.

The McGraw-Hill firm have produced many fine books on technical and semi-technical subjects, but none which does them more credit than this—an undertaking which, the Introduction discloses, they first proposed to Wilbur and Orville Wright in 1909, 44 years ago; surely an outstanding example of publishing prescience. In the concluding paragraph of that Introduction, Mr. McFarland pays a tribute to the editors of *The Papers of Thomas Jefferson*, that stupendous work of which the Princeton University Press have produced so far, we believe, some eight or nine of the projected 56 volumes or thereabouts. Their own great accomplishment, he says, and their introductory essay on the tasks of editorship, " have been a challenge and an inspiration." Those who have any acquaintance with the *Jefferson Papers* will recognise the inspiration, and will appreciate, if they study also the *Wright Papers*, the care and craftsmanship with which the challenge has been met.

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TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Slip Gauge Maintenance Service. COVENTRY GAUGE AND TOOL CO., LTD., Fletchamstead, Coventry. Details of two accuracy-maintenance services for slip gauges made to B.S. 888-1950, operated by the company in conjunction with the Pitter Gauge and Precision Tool Co., Ltd., Woolwich, London, S.E.18. One service covers workshop gauges and the other deals with inspection gauges, which require a more exact examination. Classified charts are issued showing the errors, with recommendations for replacement where necessary. Leaflet illustrated by a reproduction of a typical chart.

Gland Packings. CRANE PACKING LTD., Slough, Bucks. Gland packings for such applications as pumps handling water or light oils at low temperatures, services involving highly corrosive fluids and gases at high temperatures and pressures. Descriptions of materials and methods of manufacture. Examples of balanced combination assemblies of die-formed ring gland packings. Ranges of packings and other products made from P.T.F.E. Illustrated catalogue.

Generating Plant. GENERAL ELECTRIC CO., LTD., Magnet House, Kingsway, London, W.C.2. Electrical plant for power generation; alternators, air and hydrogen cooled; protective gear; supervisory gear; automatic boiler controls and pump motors. Large illustrated booklet gives details of recent plant and includes flow diagrams, operating circuits and control diagrams, together with illustrations of turbo-alternators now in service.

Scaffolding. BRITISH BUILDING AND ENGINEERING APPLIANCES LTD., 63-65 London-road, Sandy, Beds. " No-Bolt " scaffolding and pole connectors; nuts, bolts and screws eliminated, the couplers being held by cotter pins and spring catches. Prefabricated scaffold frames, assembled by use of patented link bar. Trench struts and shore props of adjustable lengths. Illustrated leaflets.

Aluminium in Building. NORTHERN ALUMINIUM CO. LTD., Banbury, Oxfordshire. Booklet entitled *The Durability of Aluminium in Building*. Explains

how exposure to weather affects aluminium and quotes research and case histories of existing buildings to illustrate the metal's behaviour under various conditions.

Stereoscopic Viewer. CORONET LTD., 308 and 310 Summer-lane, Birmingham 19. Viewer suitable for displaying 3-D colour pictures of products. Two models described. One battery-lighted, the other, of conventional pattern, is held up to the light. Illustrated leaflet.

Display Aids for Diesel Engines. F. PERKINS, LTD., Peterborough. Instruction films, posters, models, etc., available from the makers for use by retailers of the company's engines. Full information in respect of the mobile schools available for service weeks, etc. Illustrated booklet.

Industrial Diesel Packs. F. PERKINS, LTD., Peterborough. Standard L4 (I) Diesel engine, developing 53 h.p. at 1,800 r.p.m., and accessories for different industrial uses. Illustrated leaflet giving details of engine and accessories, including performance data.

Controlled Atmosphere Furnaces. ROYCE ELECTRIC FURNACES LTD., Sir Richards Bridge, Walton-on-Thames, Surrey. Electrically-heated furnaces, using special atmospheres. For continuous or semi-continuous operation up to 1,150 deg. C. Illustrated booklet giving details.

Magnetic Separators. MAGNETIC EQUIPMENT CO. LTD., Lake Works, Portchester, Hampshire. "Magco" range of magnetic separators, disc, roll, or cross-belt types for dry feeds, and Crockett types for wet processes. Leaflet gives list of models and capacities.

Heat Exchangers and Oil Coolers. SERCK RADIATORS, LTD., Warwick-road, Birmingham 11. Radiators, heat exchangers, oil coolers, etc. Brochure illustrating the work of the various divisions of the Serck organisation; commercial and technical services, research and development, works, and servicing branches.

Thickness Gauge. SOLUS-SCHALL LTD., 18-22 New Cavendish-street, London, W.1. Magnetic gauge for measuring thickness of ferrous plates and pipes with only one side accessible; applications and method of operation. Illustrated leaflet.

Current Transformers. FOSTER TRANSFORMERS LTD., South Wimbledon, London, S.W.19. Current transformers for metering and relay operation. Two leaflets—one for standard and one for high-accuracy types, with details of models available.

Bituminous Coatings. BRITISH BITUMEN EMULSIONS LTD., Dundee-road, Trading Estate, Slough, Bucks. "Ibetol(x)" bitumen coatings, highly thixotropic, suitable for steels, concretes, etc., to prevent rust and corrosion. Illustrated leaflet.

Concrete Anti-freeze Solution. BRITISH BITUMEN EMULSIONS LTD., Dundee-road, Trading Estate, Slough, Bucks. "Kyljack" for preventing damage by frost and ice to new concretes and mortars. Leaflet.

Ovens with Forced-Air Circulation. ROYCE ELECTRIC FURNACES LTD., Sir Richards Bridge, Walton-on-Thames, Surrey. Electric ovens operating up to 550 deg. C. with forced-air circulation. Leaflet giving sizes available.

Switching Relay. ELECTRICAL REMOTE CONTROL CO. LTD., East Industrial Estate, Harlow New Town, Essex. Relay type MIR, operating voltages 10 to 440, replaceable contacts up to 6 amps. Leaflet No. 105 gives particulars.

Dyeline Reproduction. HALL HARDING LTD., Stourton House, Dacre-street, London, S.W.1. "Unax" and "Ammonax" coatings for semi-dry and ammonia-vapour development. Leaflet describing latest improvements.

Inspection of Inaccessible Parts. J. BODSON & FILS, 14bis Rue Denis-Papin, Puteaux (Seine), France. "Endoscopes," to inspect interiors of hollow bodies; general principle and applications; different viewing devices. Illustrated pamphlet.

Fluorescent Handlamps. BRITISH CENTRAL ELECTRICAL CO., LTD., 6-8 Rosebery-avenue, London, E.C.1. Portable fluorescent handlamps, shock resisting and waterproof. Single 8-watt and double 6-watt tubes. Illustrated leaflet.

Battery-Operated Tape Recorder. BOOSEY AND HAWKES, LTD., Sonorous Works, Deansbrook-road, Edgware, Middlesex. "Reporter" portable tape recorder, battery operated and weighing 12½ lb. 15 minutes duration per spool. Illustrated leaflet.

Hack Saw Frame. JAMES NEILL & CO., LTD., Napier-street, Sheffield 11. "20 T" hack-saw frame with new design of handle and tubular bars with elliptical section. Illustrated leaflet.

Fork-lift Trucks. HYSTER CO., P.O. Box 4318, Portland 8, Oregon, U.S.A. Field report No. 50 on handling of dairy products with fork-lift trucks. Illustrated leaflet.

BOOKS RECEIVED

Some of the books noticed in the Books Received column are selected for extended review in later issues of ENGINEERING.

Note on the Results of Some Profile Drag Calculations for a Particular Body of Revolution at Supersonic Speeds. By J. R. WEDDERSPOON and A. D. YOUNG. Report No. 81. *The Librarian, The College of Aeronautics, Cranfield, Bletchley, Buckinghamshire.* (5*s.*)

The results indicate that the overall difference in profile drag for a particular body of revolution at supersonic speeds, between fully laminar and fully turbulent flow, decreases rapidly with mainstream Mach number, and rather more rapidly than does the corresponding difference for a flat plate. At Mach numbers greater than about 2 the profile drag of the body with fully turbulent flow is less than that of a flat plate. However, certain factors which have not been taken into account may appreciably alter values for the high end of the Mach number range considered, and a further series of calculations is planned in which allowance will be made for these factors.

The Dock Worker: An Analysis of Conditions of Employment in the Port of Manchester. The University of Liverpool, Department of Social Science. *The University Press of Liverpool, Liverpool,* 3. (17*s.* 6*d.*)

This survey of life and labour in the Port of Manchester was undertaken during the winter of 1951-52 to examine the impact on dock workers of the post-war Dock Labour Scheme, and to find out how they reacted to the changed conditions. The answers to a series of questionnaires have been analysed and summarised to show the attitude of the dock workers to the organisation of their work, to the authorities who manage and employ them, to their trade union, and to their wages and working conditions.

Elements of Food Engineering. Vol. III: Unit Operations—2. By MILTON E. PARKER, ELLERY H. HARVEY and E. S. STATELER. *Reinhold Publishing Corporation,* 330 *West* 42*nd-street, New York* 36, *N.Y., U.S.A.* (6·75 dols.); and *Chapman and Hall, Limited,* 37 *Essex-street, London, W.C.*2. (54*s.*)

The publication of this book completes the set of three volumes. Volume III continues the discussion of unit operations, and covers evaporation and distillation, dehydration and drying, regulating and control systems, and packaging.

Engineering Drawing Problems. By FRANK ZOZZORA. *McGraw-Hill Book Company, Incorporated,* 330 *West* 42*nd-street, New York* 36, *N.Y., U.S.A.* (3·75 dols.); and *McGraw-Hill Publishing Company, Limited,* 95 *Farringdon-street, London, E.C.*4. (30*s.*)

The work sheets in this book are intended to be read in conjunction with the book "Engineering Drawing," by the same author. The problems have been selected in order to acquaint the student with the necessary basic rules and conventions. The various kinds of paper generally employed in industry have been used so that the student may experience the particular conditions presented when working on cross-section, tracing, or opaque papers.

Glossary of Irrigation and Hydro-Electric Terms and Standard Notations Used in India. Central Board of Irrigation and Power, Publication No. 5. Third edition. *Central Board of Irrigation and Power, Curzon-road Barracks, New Delhi, India.* (No price given.)

This book, first published in 1934, contains technical terms and vernacular expressions used throughout India in the notes and engineering articles written by members of the Board, research officers and others connected with the profession. It is divided into five parts covering standard notations, vernacular terms associated with irrigation, technical terms connected with irrigation, technical terms connected with ground water and tube wells, and electrical engineering terms.

S.B.A.C. Handbook of Recommended Basic Training Exercises, Vol. I. *The Society of British Aircraft Constructors, Limited, Technical Section, Summit House,* 1-2 *Langham-place, London, W.*1. (95*s.*).

This book contains a syllabus suitable for probationary apprentice training in the aircraft industry. Exercises related to the syllabus have been chosen by the Society's Education and Training Panel so that a selection can be made to suit a variety of requirements. Examples range from elementary exercises in filing, drilling, sawing, tapping, reaming, etc., associated with an introduction to the use of hand tools, to details of simple fitting and machining operations leading to the assembly of typical tools and workshop equipment.

Water Supply of Greater London. By H. W. DICKINSON. *The Newcomen Society, The Science Museum, South Kensington, London, S.W.*7. (35*s.*)

This book consists of a series of articles originally published in *The Engineer* in 1948, and now revised and issued as a Memorial Volume and a tribute to the author by the Newcomen Society. Subjects covered include supply by streams, wells and conduits, the introduction of pumping, pumping by water and animal power, pumping by steam, supply by statutory companies, and the Metropolitan Water Board.

Analysis of Deformation. Vol. II: Experiment and Applied Theory. By KEITH SWAINGER. *Chapman and Hall, Limited,* 37 *Essex-street, London, W.C.*2. (70*s.*)

In the second volume of this work the theory formulated in volume I is applied, and the available experimental evidence is examined for the equilibrium deformation of various solids having various boundary conditions. This volume is more concerned with practical aspects, so that in some cases approximations are made as required, but the nature of the approximation is indicated when compared with the rigorous theory. Subsequent volumes will deal with subjects such as thin plates, buckling, stress propagation and vibrations.

Modern Physics for the Engineer. Edited by LOUIS N. RIDENOUR *McGraw-Hill Book Company, Incorporated,* 330 *West* 42*nd-street, New York* 36, *N.Y., U.S.A.* (7·50 dols); and *McGraw-Hill Publishing Company, Limited,* 95 *Farringdon-street, London, E.C.*4. (53*s.* 6*d.*)

This volume consists of a collection of lectures delivered to an extension course at the University of California during 1952-53. Part I, "The Laws of Nature," includes relativity, atomic structure, physics of the solid state, magnetism, nuclear power and elementary particles. Part II, "Man's Physical Environment," deals with the application of physical laws and techniques of investigation to the study of the universe, the earth and the air. In the third part of the book the chapters deal with the application of physics to electronics under the heading of "Information and its Communication."

Massbalancing of Aircraft Control Surfaces. By H. TEMPLETON. Aeronautical Monographs, Vol. IV. Published under the Authority of the Royal Aeronautical Society. *Chapman and Hall, Limited,* 37 *Essex-street, London, W.C.*2. (35*s.*)

This book deals specifically with the application of massbalancing to the prevention of flutter of aircraft control surfaces. The main objects are to provide an understanding of the basic principles underlying the application, and to give a factual account of the historical development and present-day application of the mass-balance principle.

Compressed Air Handbook. Compressed Air and Gas Institute. Second edition. *McGraw-Hill Book Company, Incorporated,* 330 *West* 42*nd-street, New York* 36, *N.Y., U.S.A.* (8 dols.); and *McGraw-Hill Publishing Company, Limited,* 95 *Farringdon-street, London, E.C.*4. (57*s.* 6*d.*)

This is a reference book on all phases of industrial air and gas compressors and compressed-air-powered portable tools and rock drills used in industry. The information presented covers the theory, selection, application, installation, testing and maintenance of this equipment. The second edition contains information on recent advances in centrifugal compressors, the latest uses of compressed-air power, new developments in displacement-type compressors, and recently-developed maintenance techniques.

English-Italian—Italian-English Technical Dictionary. By GIORGIO MAROLLI. Fifth edition. *Le Monnier Editore, Florence, Italy.* (7,500 lire.)

In the fifth edition of this dictionary, many new terms covering special technical fields have been added. Words covering recent military, aviation and naval developments have also been included. As an appendix there is a set of 35 drawings, covering various aspects of engineering and technology, of which the legends are given in English and Italian.

Preparation and Burning of Peat as a Domestic Fuel. By H. P. HUDSON and T. R. SKERRY. Memorandum Series No. 127. *Department of Mines and Technical Surveys, Mines Branch, Ottawa, Canada.* (25 cents.)

This paper describes the designing and testing of a simple peat burner for domestic use in rural areas near the sources of peat supply. It also contains recommendations for the most effective preparation of peat for such a burner.

The Engineering Outlook—1

BRITAIN'S PLACE IN WORLD ENGINEERING

II—RAW MATERIALS: CONSUMPTION AND PRICES

Last year in the corresponding article we remarked that one of the major uncertainties in the outlook for the engineering industries was the course of raw material prices. This year there is more stability and much firmness in the price structure, but the leading economies of the world are at full stretch and any uncertainty that exists now concerns the availability of raw materials. One of them, nickel, is already acutely scarce and others could quickly become so. Imports of steel, mainly sheet and tinplate, will have to be increased and exports of coal almost certainly reduced, unless imports of United States coal are increased.

During 1954 engineering production expanded considerably throughout Europe, despite a fall in re-armament, particularly in Germany, Italy and the United Kingdom. The rapidity of the increase in engineering output would almost certainly have uncovered shortages of a good many materials had not a recession in North America led to a reduction of United States imports and made available substantial quantities for export. But the United States is now recovering: industrial production, which declined from 110 per cent. of the 1952 average in June, 1953, to 102 at the end of the year and further to 99 in March, 1954, had recovered to 104 in November.

We can therefore expect a rise in the United States consumption of engineering materials, and consequently a rise of imports; it follows that prices will tend to harden and in some cases to rise substantially. There is, of course, the possibility that the United States Government might alter the situation by changing its stock pile policy. Some of the non-ferrous metals, for example, such as copper or nickel, could be made relatively plentiful if the United States government suspended purchases, but such a change of policy is most unlikely. 1955 might, therefore, be a year of some scarcity though not significant unless it were accompanied by excessive buying for stock by individual firms. On the whole, however, British engineering can expect to continue to enjoy the steady and uninterrupted supplies of materials that have been such a fillip to production during the past 18 months.

The rising trend in material prices mentioned above can be seen in Fig. 1. The price index of materials used in mechanical engineering rose seven points during the first 11 months of last year, and stood in November at 154·4, one point higher than the 1952 peak and over 11 points higher than in June, 1953. The index of materials used in electrical engineering has also risen sharply throughout the year though still two points below the 1952 peak. Provided demand for vehicles and durable consumer goods is maintained at the present high level, an increase of 10 to 15 points in the materials price index is likely to take place during the current year. This is unfortunate, since it carries the danger of inflation and will almost certainly bring about a worsening of the terms of trade for this country. On the other hand, the income of primary producing countries will increase and so enable them to increase their imports of engineering products.

TRENDS IN NON-FERROUS METALS

The prices of all non-ferrous metals, except aluminium and tin, hardened considerably during the past year, as can be seen from the Board of Trade's Wholesale Price Index shown in Fig. 2. Even in the case of those two metals, however, there was a notable improvement: tin had recovered about a third of the 65 per cent. fall which took place between February and August, 1953, and has remained fairly steady since March. Aluminium prices have been unchanged since February. The most remarkable feature of non-ferrous metals price movements during 1954 has been their immunity to the United States recession during which that country's Government has continued to encourage (and in some cases, to finance) expansion of the production of most metals. This is particularly so in the case of copper and aluminium. Great confidence is being expressed by aluminium producers in the long-term prospects for the metal. Last August, the Aluminium Company of Canada's new smelter at Kitimat produced its first ingot, and plans are already approved for the immediate expansion of its 90,500 tons annual capacity by 60,000 tons at the cost of 45 million dols. Hydro-electric facilities were built to enable an ultimate output of 300,000 tons a year and approximately half this will have been achieved by 1956. The expansion programme of the parent company, Aluminium, Limited, costing more than 465 million dols., is now almost complete although further developments are likely in Alaska during the next few years. The Aluminium Company of America (ALCOA) put forward plans for a huge power and aluminium reduction plant at Skagway, Alaska, some two years ago. These were rejected by the Canadian Government but it now seems likely that the plant will be erected by a joint United States-Canadian undertaking.

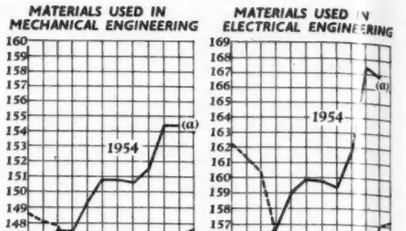

Fig. 1 United Kingdom wholesale price index numbers (1949 = 100). (a) provisional figure.

Aluminium, Limited, recently announced that sales to the United Kingdom during 1955 were expected to reach 250,000 ingot tons compared with 184,000 tons in 1953. Available statistics for consumption during 1954 show that it was 18 per cent. higher during the first nine months than in the corresponding period of 1953 and the expectations of Aluminium, Limited, are therefore likely to be realised. It is now becoming fairly clear that there is a long-term upward trend in the world consumption of the metal, but that the major uses—vehicle and aircraft manufacture and building—are tied to a high standard of living.

Consumption of copper has continued to increase, and its price has risen sharply during the second half of the year; during the first nine months consumption of virgin and secondary copper was over 30 per cent. above the 1953 level, and was increasing. The firmness of copper prices was against the expectations of most users, who kept stocks down to a minimum, and in spite of every adverse factor—the restoration of private dealings, a huge surplus in Chile and a recession in the United States. The Ameri-

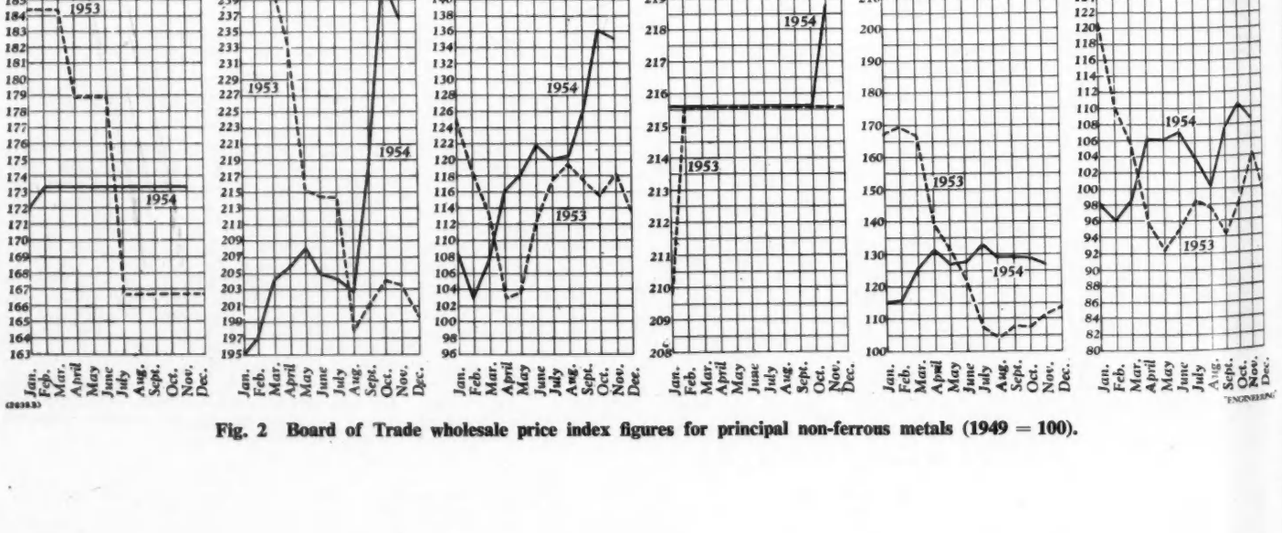
ALUMINIUM (VIRGIN INGOT) DELIVERED
COPPER, EX-WAREHOUSE
LEAD, EX-SHIP WHARF OR WAREHOUSE
NICKEL, REFINED, DELIVERED
TIN, INGOT, MIN. 99·75 PER CENT. SETTLEMENT PRICE
ZINC, EX-SHIP, WHARF OR WAREHOUSE
1953
1954
Jan. Feb. Mar. April May June July Aug. Sept. Oct. Nov. Dec.
"ENGINEERING"

Fig. 2 Board of Trade wholesale price index figures for principal non-ferrous metals (1949 = 100).

can stock-pile prevented the Chilean surplus from being unloaded on the market—100,000 tons were purchased at 30 cents per lb.—and reduction in output in the United States and Chile did more than was required to keep prices level. The developments of the past year suggest that copper prices are most unlikely to fall very far, even in the event of a recession. The industry's confidence has been clearly demonstrated by the expansion plans that have been published during the year. The Northern Rhodesian copperbelt, which in 1954 displaced Chile as the second largest production centre, has plans for expansion of output to just under 500,000 tons a year by 1958. Total production has doubled in the past eight years, and reached 400,000 tons in 1954. Huge sums of money have been poured into the copperbelt since the war, including £9 millions into the new Bancroft mine with a further £3 millions needed to complete the scheme which will bring the mine into production late in 1957, working up to its rated capacity of 48,000 tons a year in 1958. The largest expansion in copper production will, however, be in the United States where output is expected to rise by about 250,000 tons a year by 1956-7. Smaller increases are planned in Canada, Chile and elsewhere.

The industry, however, has shown remarkable confidence that this vast increase in world supplies will not depress the market. Strategic needs play a big part in this confidence. The expansion of production in the United States has been underwritten by the Government which undertakes, if required, to purchase the total increase for its strategic stock at prices ranging down to about 24 cents a lb. (£192 a ton). The U.S. Government is also taking copper and cobalt (which is playing an increasingly significant part in the development of copper mines) against its loans to the Rhodesian and other overseas producers. If the demand, however, proved inadequate to absorb rising supplies, there is little doubt that U.S. and Chilean producers are fully prepared to defend prices by restricting production as they did last year when demand declined sharply. Looking back, this decline was almost entirely due to a general anticipation of a fall in price, leading fabricators and other users to reduce stocks, a most unlikely occurrence in 1955.

NICKEL SHORTAGE

The scarcest non-ferrous metal is undoubtedly nickel, of which an acute shortage has developed in recent months with no visible prospect of any improvement in supplies. British users have requested the Government to intervene and to secure more adequate supplies for this country, but the shortage is world-wide. Total supplies are estimated to fall short of current needs by at least one-fifth, and reports from the United States and the Continent suggest that industrial users who enjoy no special priority have fared far worse in those countries than in Britain. The supply position is, of course, made worse by purchases by governments, particularly in the United States, for strategic stock. This is one of the results of the widening applications of the metal and has tended to emphasise the changes in the pattern of demand since the Korean war. Consumption in the manufacture of high-temperature alloys, needed for jet engines and gas turbines in increasing quantities, now accounts for over 15 per cent. of total consumption compared to 10 per cent. four years ago. Dr. John F. Thompson, chairman of the International Nickel Company of Canada—which accounts for about four-fifths of current world production—anticipates a continuous increase in the demand for nickel as a result of the likely adoption of the gas turbine for many industrial purposes, pointing out that virtually all of the special alloys developed for aeroplane gas turbines or jet engines in the past 15 years contain nickel, in quantities ranging from 10 to 70 per cent. Despite the acute shortage, the price of nickel has risen less than that of most other metals, from 37 cents per lb. before the war to 64½ cents per lb. (£519 a ton), the latest rise being of 4½ cents per lb. last November.

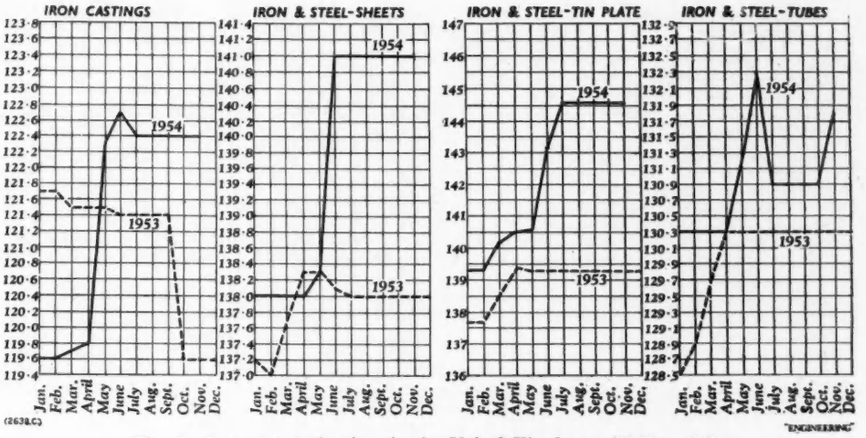

Fig. 3 Iron and steel prices in the United Kingdom. (1949 = 100).

The U.S. Government is paying 1 dol. per lb. for its stockpile purchases, which amount to 12,000 tons a year from I.N.C.C. and a similar proportion from other producers (estimated to amount to about 8 per cent. of annual world output). This premium has enabled the low-grade deposits to be opened up, and therefore compensates to some extent for the heavy demands made by the United States on world supplies. On the Continent, however, much higher prices are being paid for nickel from some sources; considerable tonnages have been bought for £1,100 a ton, and in the United Kingdom scrap prices have risen to over £600 a ton. The very high current output of cars and household appliances has contributed to the present shortage, although recent estimates show that consumption for high-temperature alloys (15 per cent.), and for alloy steels, nickel-iron alloys and cast iron (55 per cent.) is relatively very important. Some form of allocation by the leading suppliers is already in force and little change in the situation is anticipated.

PROMISING NEW MATERIALS

Several definite advances were made in the production in this country of new materials that are likely to become increasingly important to engineering production. Most progress has probably been made with titanium, which has qualities of tensile strength, lightness and resistance to heat and corrosion sufficiently outstanding to make it the automatic choice in many applications for the manufacture of aircraft, turbines (both gas and very high pressure steam) and certain items of chemical plant. The main obstacle to its wider use has so far been scarcity and high cost. The announcement by Imperial Chemical Industries, Limited, last October, that they are building a titanium plant with a capacity of 1,500 tons a year, is therefore of considerable interest. Production is to start during the current year and a substantial increase in the use of the metal is therefore expected to take place (ENGINEERING, vol. 178, page 515, 1954).

The increase in United States output since production started in 1948 has been considerable: 5,000 tons are expected to have been produced in 1954. The United States Defence Department has called for 30,000 tons a year within three years, and expects its needs to reach 100,000 tons a year by 1960. The price of the metal, however, is still very high—between 8 dols. and 20 dols. per pound—and it is likely to be a few years before titanium becomes cheap and abundant enough for non-strategic industrial uses. The difficulties in reducing production costs have proved a disappointment to many potential users who expected the metal to solve all their stress and temperature problems.

Plastics are quickly gaining ground as an engineering material. The production of thermoplastics, widely used for insulation purposes in the electrical and instrument industry, is inadequate to meet demand, although it is expected to have been 25 per cent. greater in 1954 than in 1953. Output of polythene, a third of which goes into electric-cable manufacture, is estimated to have increased from 12,000 tons in 1953 to 20,000 tons last year, and plans are under way for extending capacity to 55,000 tons in 1957. Output in the United States is currently at the rate of about 100,000 tons a year and seven new factories now under construction are expected to double capacity. The output of polystyrene, the biggest single use for which is in the refrigeration industry, is expected to increase from 20,000 tons last year (estimated) to 30,000 tons this year. Despite the quickly rising output of polystyrene and polythene, P.V.C. remains the main thermoplastic available for industry.

Several new plastics have come to the fore during the past year. Kralastic, (a blend of resin and rubber) produced by the Naugatuck Chemical Division of United States Steel Corporation, accounts for some 15 per cent. of all plastic tube produced in the United States, and output is being trebled. The growth of the use of plastics for tube manufacture has been staggering. According to the United States Society of the Plastics Industry, about 5 million lb. of plastics were used in 1950, and this had increased to 30 million lb. in 1954.

Another new plastic, "Epikote" resin, will be produced in this country by the Shell Refining and Marketing Company, Limited, at the rate of 1,000 tons a year from the middle of this year. Production was begun by the Shell Petroleum Company in the United States five years ago, and is now running at the rate of 11,000 tons a year. The uses of Epikote resins were described in an article last month (ENGINEERING, December 31, p. 848). The main use is in combination with other materials to produce coatings and finishes, but its suitability for the manufacture of dies for the motor vehicle and light metal industries, and its outstanding adhesive properties make it one of the most promising of the new engineering materials.

IRON AND STEEL SUPPLIES

The rise in industrial production in 1954 has required 4½ per cent. more steel, which was met in a broad sense by a 5 per cent. increase in crude steel output. Prices of certain steel and iron products are shown in Fig. 3, and production of steel ingots and iron castings is shown in Fig. 4. Certain types of steel became short early in the year, and towards the end shortages had become more general and imports increased. Consumers' stocks remain low but there is little fear that industrial output will be curtailed, athough some of the products in short supply might become harder to import should the United States industrial production recover more quickly than is anticipated. The quantities required, however, are marginal and could probably be obtained from other sources. The

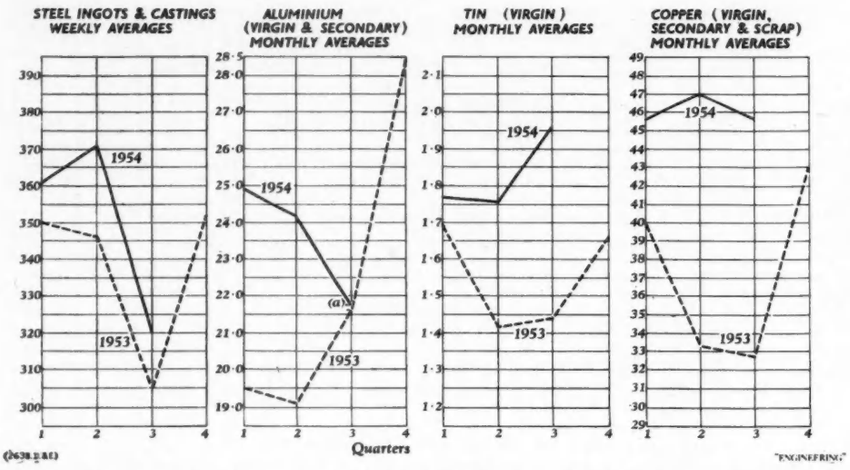

Fig. 4 U.K. production of steel ingots and castings: weekly averages (1,000 tons).

Fig. 5 United Kingdom consumption of major non-ferrous metals (1,000 tons). (*a*) estimated September figures for secondary aluminium not published.

British steel industry expects output in 1955 to reach 19¼ to 19½ million ingot tons, which should suffice to meet demand even if imports prove difficult to secure. Such an output should enable the industry to deliver 4 to 5 per cent. more steel than last year, enough to meet an increase of 5 to 6 per cent. in industrial production. This is based on the yardstick sometimes used by the industry that a 10 per cent. rise in the output of the main steel-consuming industries —engineering, vehicles and "metal goods not elsewhere specified"—entails a rise of about 8 per cent. in steel requirements. This ratio works out fairly well for any five-year period since the war. Since 1946 industrial production has risen by some 45 to 50 per cent., measured by the official index, including a rise of over 60 per cent. in the output of the engineering and vehicle industries. Over the same period, home deliveries of steel increased by about 40 per cent., but, if changes in stocks are taken into account, consumption probably rose by 45 per cent., which suggests that a 7½ per cent. increase in steel supplies was in fact required to meet every 10 per cent. increase in engineering and vehicle output.

The shortage of steel consists almost entirely of rolled products, particularly sheet and tinplate. It is in 1955, however, that the greatest increases in the output of flat steel are expected. The Steel Company of Wales' Margam rolling mill will have a full year's operation, and additional capacity will be commissioned at Ebbw Vale and Shotton. Despite this, sheet is likely to remain in short supply, and the motor vehicle manufacturers have already announced that they are prepared to import their own sheet. The shortage of tinplate will be relieved somewhat by the commissioning of a new five-stand mill at Ebbw Vale, but this is also unlikely to meet the canning industry's full requirements and it is comforting therefore, from the latter's standpoint, that the tinplate companies are prepared to meet the shortfall in their own production by imports which they will sell to their customers at the prevailing British prices. Contrary to our own expectations a year ago, the shortage of sheet has proved more intractable than that of plate, of which supplies to shipyards and rolling stock manufacturers appear to be much improved. The vast increase in the demand for flat steel, to a level higher than the steel industry's own generous estimates is the most basic, and hopeful, turn of events of the late year.

ANOTHER STRIP MILL?

In a recent statement on the steel supply position, the British Iron & Steel Federation point out that if an output of 19¼–19½ million tons is realised in 1955, the industry should be more than able to meet the requirements of 21 million tons estimated some years ago for 1957–58. They say, however, that "the recent performance of the motor car industry has surpassed the best expectations of five years ago" and foreshadow the possibility of a review of the industry's forward estimates of consumption in the light of the circumstances of 1954, although no change in the expansion programme was indicated by a review of the 1957–8 estimates in the light of the circumstances of 1953. Expansion of output of flat products at Margam, Ebbw Vale and Shotton is estimated to yield 10 to 15 per cent. more sheet and tinplate this year, and further increases are expected in the following two to three years. There will come a time, however, when a further large increment of capacity for flat rolled products will be necessary. This would have to consist of a large modern strip mill with all ancillary iron and steel making facilities "costing something of the order of £100 millions and with an annual capacity of perhaps a million tons of flat products."

The need for this will be dictated by the rate of growth of the motor car and engineering consumer goods output. Although these industries have planned vast extensions to capacity, they have yet to demonstrate their ability to sell their products in rapidly increasing quantities both at home and in overseas markets. Their future depends on a rising standard of living in the United Kingdom and in primary producing countries, and on the avoidance of war. The odds would seem to be in their favour, provided exports can be increased to support a continued rise in the British standard of living, and provided this rise is not at the expense of our customers overseas. There are snags, but the outlook has never been more favourable, and the changes in the structure of British engineering that are entailed are both basic and revolutionary. Sooner or later a new wide strip mill will be built, probably sooner.

A fuller discussion of the strip-mill problem appears on page 36. A series of articles dealing with the main branches of the industry is to follow in subsequent issues.

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INDEX TO "ENGINEERING"

Volume 177 now ready

The Index to Volume 177 of ENGINEERING (January-June, 1954) is now ready and will be sent to any reader, without charge and postage paid, on application being made to the Publisher, 35 and 36, Bedford-street, London, W.C.2. Any reader wishing to receive regular copies of the Index as they are published can apply to be put on the mailing list. Those already on the mailing list need not re-apply.

LAUNCHES AND TRIAL TRIPS

S.S. "BRITISH VICTORY."—Single-screw oil tanker, built by Vickers-Armstrongs Ltd., Barrow-in-Furness, for the British Tanker Co., Ltd., London, E.C.2. Second of two sister ships for these owners. Main dimensions: 630 ft. between perpendiculars by 85 ft. 6 in. by 46 ft. 8 in.; deadweight capacity, about 32,100 tons. Parsons double-reduction geared steam turbines of Pametrada design, developing 12,500 s.h.p. at 112 r.p.m. Speed, 14¾ knots. Launch, December 13.

S.S. "SOUTH AFRICAN MERCHANT."—Single-screw cargo vessel, with accommodation for twelve passengers, built and engined by the Fairfield Shipbuilding and Engineering Co., Ltd., Glasgow, for the South African Marine Corporation, Cape Town. Main dimensions: 490 ft. by 62 ft. 6 in. by 40 ft. 9 in.; deadweight capacity, about 12,500 tons. Propulsion by geared marine steam turbines. Launch, December 14.

M.S. "KANDAW."—Single-screw cargo vessel, built by Lithgows, Ltd., Port Glasgow, for the British and Burmese Steam Navigation Co., Ltd. (Managers: P. Henderson & Co.), Glasgow. Main dimensions: 430 ft. by 50 ft. by 37 ft. 3 in.; deadweight capacity, 9,300 tons. Diesel-engined propelling machinery, constructed by John G. Kincaid & Co., Ltd., Greenock. Launch, December 15.

M.S. "VINDAFJORD."—Single-screw vessel for use as combined ore-carrier and oil tanker, built and engined by the Götaverken Shipyard, Gothenburg, Sweden, for Skibs A/S Malmtransport, Oslo, Norway. Main dimensions: 489 ft. overall by 59 ft. by 35 ft. 6 in.; deadweight capacity, about 12,200 tons on a draught of 27 ft. 9 in. Götaverken seven-cylinder single-acting two-stroke Diesel engine, developing 4,200 b.h.p. at 112 r.p.m. Speed, about 13½ knots, fully loaded. Launch, December 17.

M.S. "VASSILIKI."—Single-screw oil tanker, built by the Furness Shipbuilding Co., Ltd., Haverton Hill, County Durham, for the Nueva Vista Compania Naviera S.A., Panama. Main dimensions: 496 ft. between perpendiculars by 67 ft. 6 in. by 36 ft. 5 in.; deadweight capacity, about 16,160 tons on a draught of 29 ft. 1 in. Hawthorn-Doxford five-cylinder single-acting two-stroke oil engine, developing 5,500 b.h.p. at 115 r.p.m., constructed by Hawthorn Leslie (Engineers) Ltd., Newcastle-upon-Tyne. Trial trip, December 20.

M.S. "HANNINGTON COURT."—Single-screw cargo vessel, built by Bartram and Sons, Ltd., Sunderland, for the Court Line Ltd. (Managers: Haldin & Co., Ltd., London, E.C.3). Main dimensions: 445 ft. between perpendiculars by 62 ft. by 40 ft. 2 in. to shelter deck; deadweight capacity, about 10,800 tons on a draught of 26 ft. 11¾ in. Kincaid-Burmeister and Wain-Harland and Wolff six-cylinder single-acting four-stroke Diesel engine, designed to operate on heavy-fuel oil and developing 3,300 b.h.p. at 110 r.p.m. in service, constructed by John G. Kincaid & Co., Ltd., Greenock. Service speed, 12½ knots. Trial trip, December 20 and 21.

M.S. "DANALAND."—Single-screw oil tanker, built and engined by the Eriksbergs Mek. Verkstads Aktiebolag, Gothenburg, for the Rederiaktiebolaget Motortank (a member of the Broström group of companies), Gothenburg, Sweden. Sister ship of the M.S. Markland. Main dimensions: 526 ft. between perpendiculars by 69 ft. 9 in. by 39 ft. 3 in.; deadweight capacity, about 18,000 tons on a draught of 30 ft. 5 in.; oil-tank capacity, about 842,000 cub. ft. B. and W. seven-cylinder single-acting two-stroke Diesel engine, developing about 8,200 b.h.p. Speed, 15½ knots, fully loaded. Launch, December 21.

M.S. "HAMINA."—Single-screw cargo vessel, built and engined by John Lewis and Sons, Ltd., Aberdeen, for A/S William Hansen Rederi II, Bergen, Norway. Vessel designed principally for the carriage of timber cargoes. Main dimensions: 305 ft. overall by 44 ft. by 21 ft. 9 in.; gross tonnage, 2,408; deadweight capacity, 3,016 tons. Lewis-Doxford opposed-piston oil engine, developing 1,450 b.h.p. at 145 r.p.m. Completed, December 22.

S.S. "ESSO EXETER."—Single-screw oil tanker, built by Vickers-Armstrongs Ltd., Walker-on-Tyne, for the Esso Petroleum Co., Ltd., London, S.W.1. Second of an order for two vessels for these owners. Main dimensions: 628 ft. overall by 82 ft. 6 in. by 42 ft. 6 in.; deadweight capacity, about 26,650 tons. Parsons geared marine steam turbines developing a maximum of 13,750 s.h.p. at 115 r.p.m. Steam supplied by two Babcock and Wilcox boilers. Machinery to be installed by the shipbuilders at Barrow-in-Furness. Launch, January 5.

THE SHEAR CENTRE OF BEAM SECTIONS

EXPERIMENTAL DETERMINATION

By N. S. J. Grassam, B.SC. (ENG.), PH.D.*

For many years structural engineers and others have successfully used standard rolled steel sections for beams with little if any regard for the torsional stiffness of the beam. The line of action of the load has been considered to act through the centre of area of the section—and if this was the case then many have thought that only bending of the beam could occur. With an I-section this is correct, but it is not correct for, among other sections, the channel. This is due to the distribution of shear stresses which, with asymmetrical open-sided sections, have a resultant which does not pass through the centre of area of the cross section. The resultant does, however, always pass through a point known as the shear centre which is fixed relative to the cross section. If the line of action of the applied force does not pass through the shear centre, then the beam twists as well as bends.

In many civil-engineering applications using rolled steel sections this possible rotation is fortunately unimportant notwithstanding the poor torsional stiffness of the normal beam section. In the aircraft industry, however, open sections both in simple and built-up members are often employed and are usually much thinner than conventional sections. The rotation which may result from the application of transverse loads to such members certainly cannot be ignored. The position of the shear centre and the torsional stiffness of the section must therefore be found.

It is possible to calculate the position of the shear centre for a given cross section as has been shown, for example, by J. S. Terrington,† and then to calculate the torsional stiffness. Such calculations, however, generally assume that the section is perfectly free to distort under load and is in no way constrained by the method of application of the load—an unlikely situation in practice except at considerable distances from the loading points.

To determine these quantities experimentally requires a device which will not be affected by bending deflections and will freely permit warping of the section. It must also be able to detect very small amounts of twist. The illustrations in Figs. 1 and 2 show an arrangement which has been found to be very successful for a channel and a semi-circular section.

It consists of a pillar rigidly attached to the specimen by two bolts. At the free end of this pillar is a frictionless hinge (shown in the inset in Fig. 2) formed by crossed leaf springs and carrying a rigid member supporting the barrel of a 1-in. by 0·001-in. screw micrometer and a 2-in. spirit level. The micrometer head presses against a 6-mm. diameter steel ball held captive in a lightweight cage on a face of the member under test.

The rotation under load is measured by adjusting the micrometer until the bubble of the spirit level is central. The angle of twist under a given increment of load is then the change in micrometer reading divided by the radius arm from the hinge to the point of contact with the ball and, as used, this device can detect a rotation of about 0·02 deg. To avoid effects due to end movements two such gauges are fixed to the member and the difference between the two micrometer readings used for calculations.

In the Engineering Laboratories of the University of Southampton these gauges are used to find the shear centre of rolled light-alloy sections mounted as horizontal cantilevers, as shown in Fig. 1. The cross section at the fixed end of the cantilever is completely prevented from movement by securing it to a ½-in. thick plate made to fit the open side of the section. This plate is bolted to a steel plate permanently attached to the wall. The load is applied at the free end of the cantilever through a horizontal lever arm which is attached to a thin plate rigidly fixed into the end cross-section. A thin plate is used to allow the section freedom to warp.

To find the shear centre a given load is placed at various positions along the lever and for each position the relative rotation between the torsion gauges is noted. A graph of relative rotation against the position of the load will reveal the position of the load for which no rotation occurs—that is, the shear centre.

A typical set of readings obtained from a semi-circular section made of Duralumin, approximately 6 in. in diameter by ⅛ in. thick, is shown in the graph, Fig. 3. The readings were obtained by observing gauges which were 13 in. apart when 20-lb. and 40-lb. loads were applied at successive points ½ in. apart along the lever. The zero readings on unloading for this and other determinations have in nearly all cases been within 0·001 in. of that obtaining initially. The spirit levels used were such that a 0·005-in. movement of the micrometer produced a bubble movement of about 1/20 in.

The apparatus described is used for experimental purposes by students, but it is thought that the method of measuring the twist described might well be applied in tests on simple or built-up members of structures used in practice where, due to indeterminate end constraints, the torsional stiffness is difficult to calculate.

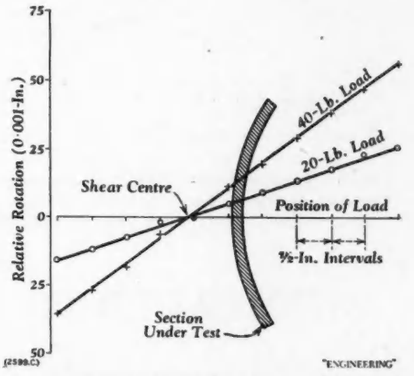


Fig. 3 The position of the shear centre is given and confirmed by the intersection of the load lines and the axis of zero relative rotation.

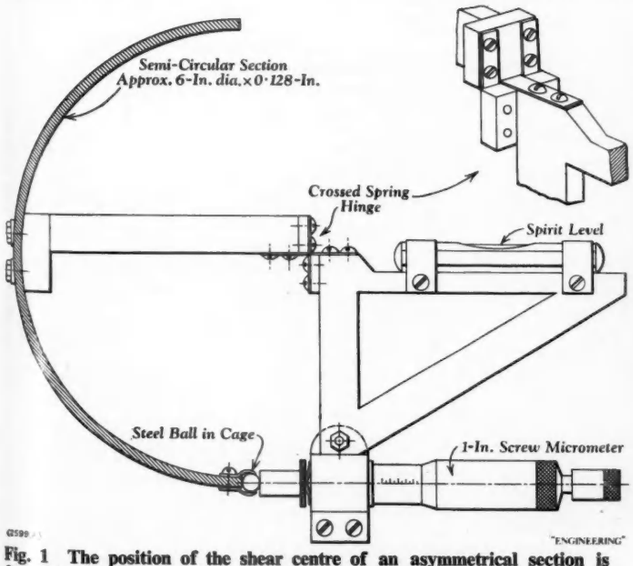


Fig. 1 The position of the shear centre of an asymmetrical section is found by determining the position of the vertical load which does not cause twisting.

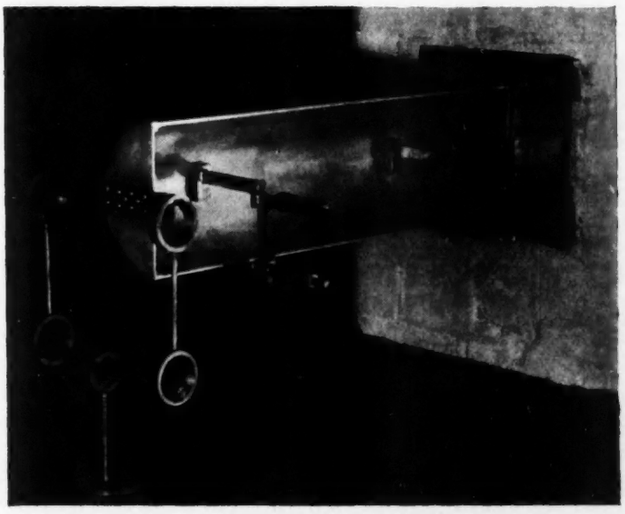


Fig. 2 The rotation of the section under load can be accurately determined by using the micrometer to measure the displacement required to return the spirit level to its initial horizontal position.

* Lecturer, Department of Mechanical Engineering, University of Southampton.

† "The Torsion Centre of Girders" by J. S. Terrington, ENGINEERING, vol. 178, page 689, November 26, 1954.

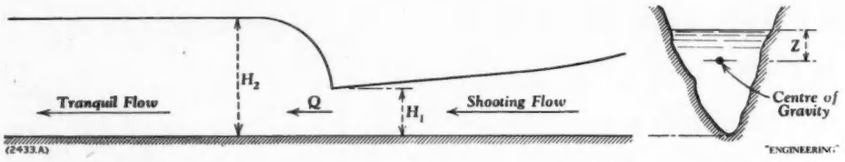


Fig. 1 Hydraulic jump. An abrupt rise occurs in the free surface of a liquid flowing in an open channel; the flow changes in character from shooting flow before the jump to tranquil flow after it, with a loss of specific energy.

HYDRAULIC JUMP IN PRISMATIC CHANNELS

DETERMINATION OF CONJUGATE DEPTHS

By W. Frazer, B.SC., A.R.T.C., A.M.I.C.E., A.M.I.MECH.E.*

Hydraulic jump (Fig. 1) is a well-known phenomenon of open-channel flow in which an abrupt rise occurs in the free surface of the moving liquid; the flow changes in character from shooting flow before the jump to tranquil flow after the jump, with a loss of specific energy. Experiments, mostly carried out in rectangular prismatic channels, have shown that the relationship between the depths of flow before and after the jump is given accurately by the principle of equating force to rate of change of momentum.

The general expression for a prismatic channel of any section, where the channel slope is zero or very small, is

$$A_1 Z_1 + \frac{Q^2}{g A_1} = A_2 Z_2 + \frac{Q^2}{g A_2}, \quad (1)$$

where

A_1 and A_2 are the cross-section areas before and after the jump respectively,

Z_1 and Z_2 are the depths from the free surface to the centre of gravity of the areas A_1 and A_2 respectively,

Q is the quantity flowing through the channel, and

g is the acceleration due to gravity.

If the channel section is rectangular, equation (1) reduces to the form

$$\frac{Q^2}{g W^2 H_1^3} = \tfrac{1}{2}\left(1 + \frac{H_2}{H_1}\right)\frac{H_2}{H_1}, \quad . \quad (2)$$

and if triangular to the form

$$\frac{2 Q^2}{g \tan^2 a \, H_1^5} = \frac{\left(\frac{H_2}{H_1}\right)^2 \left\{\left(\frac{H_2}{H_1}\right)^2 + \frac{H_2}{H_1} + 1\right\}}{\left(1 + \frac{H_2}{H_1}\right)}, \quad . \quad . \quad . \quad (3)$$

where H_1 and H_2 are the depths of flow before and after the jump respectively, W is the width of the rectangular channel, and a is the half angle of the triangular channel.

Both these expressions give a single-value relationship between the conjugate-depth ratio $\frac{H_2}{H_1}$ and the dimensionless parameters $\frac{Q^2}{g W^2 H_1^3}$ or $\frac{2 Q^2}{g \tan^2 a \, H_1^5}$ and solutions are easily obtained. ($\frac{Q^2}{g W^2 H_1^3}$ and $\frac{2 Q^2}{g \tan^2 a \, H_1^5}$ are the Froude numbers for rectangular and triangular channels respectively.)

With any other section the relationship is more complex and in general $Q = F(H_2 H_1)$ necessitates a family of curves to define the relationship for any section. Such a family of curves, covering trapezoidal channel sections, and including triangular and rectangular sections is given by O'Brien and Hickox.† It is possible, however, to obtain a single curve from which by a simple graphical construction the relationship may be obtained for any one section.

If the quantity AZ is calculated and plotted against $\frac{1}{A}$ for a particular channel section, a curve such as that shown in Fig. 2 is obtained. It is convenient to plot the depth of flow, H, against $\frac{1}{A}$ on the same diagram. Suppose that the quantity Q and the initial depth H_1 are known; on the diagram the point $\frac{1}{A_1}$, $A_1 Z_1$ can be located. Through $\frac{1}{A_1}$, $A_1 Z_1$ draw a line at angle θ where $\tan\theta$ expressed in terms of the vertical and horizontal scales, has a numerical value of $-\frac{Q^2}{g}$.

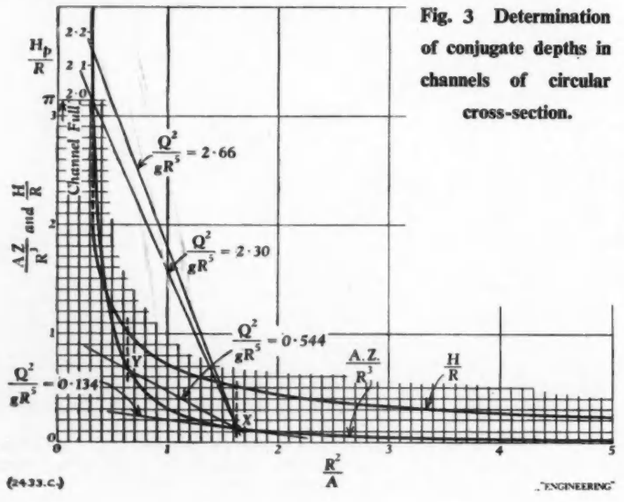


Fig. 3 Determination of conjugate depths in channels of circular cross-section.

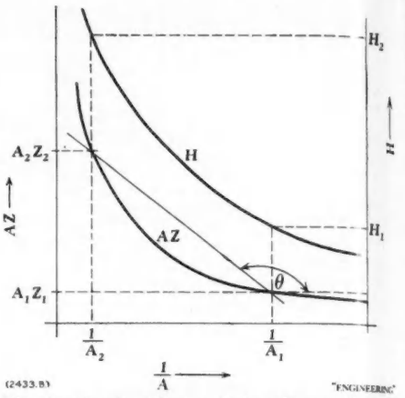


Fig. 2 Graph giving a single-value relationship between conjugate depth ratio and a dimensionless parameter for any one section.

This line intercepts the AZ curve at the conjugate point $\frac{1}{A_2}$, $A_2 Z_2$ for

$$\tan\theta = -\frac{Q^2}{g} = \frac{A_2 Z_2 - A_1 Z_1}{\frac{1}{A_2} - \frac{1}{A_1}},$$

which is equation (1). Thus H_2 may be found.

For geometrically similar channels a linear dimension may be used as a parameter. In particular, with circular channels an obvious dimension is the radius R, and the quantities involved then become $\frac{AZ}{R^3}$, $\frac{R^2}{A}$, $\frac{H}{R}$, $\frac{Q^2}{gR^5}$, all these being non-dimensional.

For studying relations at various flows it is convenient to prepare a series of $\frac{Q^2}{g}$ or $\frac{Q^2}{gR^5}$ lines on tracing paper and superpose this on the main diagram.

The following three examples show the method. In Fig. 3 the relations for a circular channel are given, the quantities $\frac{AZ}{R^3}$ and $\frac{H}{R}$ being plotted against $\frac{R^2}{A}$.

CIRCULAR CHANNEL

Consider a circular channel of 3 ft. radius and suppose it is desired to study the behaviour of the channel with varying flows at a depth of flow of 1 ft. 6 in. In this case $\frac{H}{R} = 0{\cdot}5$ and the corresponding point, X, on the $\frac{AZ}{R^3}$ curve can be located.

Example 1. Q = 65·2 cusecs, hence $\frac{Q^2}{gR^5} = 0{\cdot}544$. Through X draw XY at angle θ where $\tan\theta = -0{\cdot}544$. Projecting from Y to the $\frac{H}{R}$ curve gives $\frac{H}{R} = 1$ and hence the conjugate depth of flow is 3 ft.

Example 2. Q = 32·4 cusecs, hence $\frac{Q^2}{gR^5} = 0{\cdot}134$. On carrying out the construction it will be found that the $\frac{Q^2}{gR^5}$ line is tangential to the $\frac{AZ}{R^3}$ curve at point X. The interpretation is that a flow of 32·4 cusecs at a depth of flow of

* Department of Civil and Mechanical Engineering, Royal Technical College, Glasgow.

† *Applied Fluid Mechanics*, M. P. O'Brien and G. H. Hickox. McGraw-Hill Book Company Incorporated, New York, 1937. Fig. 143.

1 ft. 6 in. in a 3-ft. radius circular channel gives critical conditions.

Example 3. $Q = 106{\cdot}6$ cusecs, hence $\frac{Q^2}{g R^5} = 2{\cdot}30$. On carrying out the construction it will be found that the conjugate depth of flow is 6 ft.; in other words the channel is full after the jump.

If the flow be increased above 106·6 cusecs, it is obvious that the channel will surcharge and run under pressure, and it is possible to extend the diagram to cover this case.

When a closed channel is under pressure, the area and centre of gravity remain constant, and the force/rate-of-change-of-momentum relation then becomes

$$-\frac{Q^2}{g} = \frac{A_c\,(H_p - B) - A_1 Z_1}{\frac{1}{A_c} - \frac{1}{A_1}}. \quad (4)$$

where A_c is the area of the closed channel, H_p is the pressure head in the channel measured at the invert of the channel, and B is the height of the centre of gravity above the invert of the channel.

In the case of the circular channel, equation (4) becomes

$$-\frac{Q^2}{g R^5} = \frac{\pi\left(\frac{H_p}{R} - 1\right) - \frac{A_1 Z_1}{R^3}}{\frac{1}{\pi} - \frac{R^3}{A_1}}.$$

It is obvious that the vertical through $\frac{R^3}{A} = \frac{1}{\pi}$ now represents the quantity $\pi\left(\frac{H_p}{R} - 1\right)$ and for convenience this has been plotted in $\frac{H_p}{R}$ values.

Example 4. $Q = 144{\cdot}4$ cusecs, hence $\frac{Q^2}{g R^5} = 2{\cdot}66$. Carrying out the construction gives $\frac{H_p}{R} = 2{\cdot}15$, that is, the channel is under a pressure of 6·45 ft. at invert level.

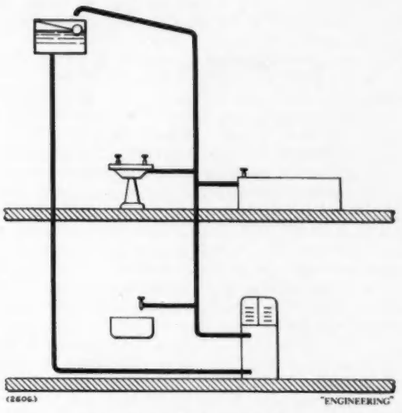


Diagram of heat-pump installation in a house; no other hot-water storage tank is required.

DOMESTIC HEAT PUMP

DUAL-PURPOSE UNIT FOR WATER HEATING AND LARDER COOLING

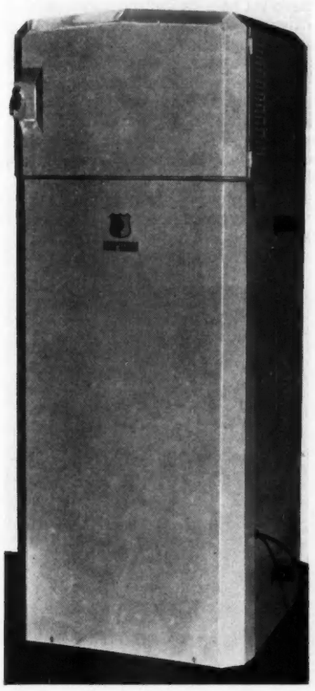
The Duotherm heat pump, made by Brentford Electric, Limited, Kidbrooke Park-road, London, S.E.3, has been designed primarily as a water heater with incidental cooling of the larder space. In the most recent model, shown in the accompanying illustration, greater advantage has been taken of the cooling properties, making the unit an efficient refrigerator as well as a water heater. Operated by a ¼-h.p. motor, the power consumption is small and spring suspension of the compressor and motor unit removes almost all vibration.

The new model is a completely self-contained unit, 2 ft. square at the base and 5 ft. 4 in. high overall. In it is a 30-gallon water tank which conforms to B.S. 699/1951, and is therefore acceptable to all Water Boards in this country. The diagram shows how the unit can be installed in a house. Cold water is supplied by way of a ball-valve cistern and the hot water is taken from the top of the tank to the taps, with an expansion pipe leading back to the cistern. No hot-water storage tank other than that in the unit is required. Fittings for 1-in. pipe are incorporated on each side of the unit to facilitate plumbing installation.

On the heating side, the unit will regularly supply 80 gallons of water a day at 140 deg. F. and this can be increased to 120 gallons under special conditions. By adjusting the thermostat the temperature can be raised or lowered over a fairly wide range, there being proportionate changes in the quantity of water available. When, however, the water in the tank has reached the set temperature, refrigeration will cease. To enable it to be continued, an automatic valve can switch the hot-water supply to a "heat leak" which may take the form of a radiator in an airing cupboard or a towel rail in the bathroom or bedroom. Heat losses from either of these will reduce the water temperature sufficiently for refrigeration to be continued.

The average coefficient of performance which has been obtained during extensive tests, has been 2·7, and this has only varied slightly with atmospheric conditions. The unit will continue to work perfectly satisfactorily with air temperatures down to 35 deg. F. It is claimed that the cost of heating the water by the pump is less than half the cost of immersion heating and the cooling is added free.

On the cooling side, the refrigeration space at the top of the unit is completely enclosed and offers 3 cub. ft. of storage. Ice cubes can be prepared and a tray for this purpose is provided. Surrounding the space is the evaporator unit (which gives the cooling) over the outside of which air is circulated by a fan. Approximately 5,500 cub. ft. of dry air per hour can be handled with a temperature reduction of 15–18 deg. F. Experiments have shown that a larder of between 100 and 120 cub. ft. is about the optimum size, and insulation of the larder space is only needed if low temperatures are required. Conditions within the food space of the unit are directly comparable to those within a standard refrigerator, which indeed, it is. The operation of de-icing, when required, can be carried out simply by switching off the unit for about half-an-hour.



The bottom of the heat-pump unit is a 30-gallon water tank at 140 deg. F.; the upper part is a refrigerator with an ice tray.

Since the driving motor is only ¼ h.p., the consumption is only of the order of 300 watts. Thus the unit can be run where only lighting circuits exist or where the loading is severely restricted. The driving motor and compressor are made in a hermetically sealed unit and do not require any attention. The spring mounting already mentioned reduces both vibration and noise to a very low level. This is increased by the immersion of the jacketed hermetic unit in the storage tank—an arrangement which makes use of the heat losses in both motor and compressor. An earlier model was exhibited at the recent Baghdad Trade Fair, and was described in ENGINEERING (vol. 178, page 539, 1954).

* * *

MAINTAINING THE APPEARANCE OF LACQUERED SURFACES

Air and Paint Pre-heaters

Faults known as "blushing" and "blooming," which spoil the appearance of cellulose-lacquered surfaces after spraying, can be overcome by means of air and paint heaters introduced by the Ecco Division of the Atlas Diesel Company, Limited, Beresford-avenue, Wembley, Middlesex. Moreover, when used in cold weather, the Atlas LE 750 air heater and FV 30 paint pre-heater enable paint to be made sufficiently liquid for spraying, without overthinning it. They are designed for use in conjunction with Ecco 30 or 303 spray guns.

Blushing and blooming arise after the spraying of cellulose lacquers owing to the presence of excessive moisture in the surrounding air. This causes a film to be deposited on the surfaces when the shop temperature is higher—by virtue of the chilling effect of compressed air—than that of the cellulose. An equally serious difficulty encountered is the tendency for operators to thin their materials too much when working outside in cold weather in order that spray equipment may work satisfactorily. The result of this is a lack of gloss in the paint finish and inadequate coverage.

The LE 750 air heater is a 750-watt electric heater into the bottom of which air passes from the compressor; the air emerges from the top at controlled temperatures ranging from 86 deg. F. to 190 deg. F. and is carried by a 12-ft. length of hose to the inlet of the FV 30 pre-heater, which consists basically of a honeycomb air coil. The lacquer passes through the pre-heater to the fluid inlet of the spray gun, which also receives air from the pre-heater. Tests have shown that with the air-heater thermostatic control fully advanced, the air temperature at the gun nozzle is between 160 deg. F. and 170 deg. F., and the lacquer after atomisation reaches a temperature of 110 deg. F.

DRILLING TITANIUM

EFFECTS OF DRILL SHAPE, SPEED, FEED, AND CUTTING FLUID

The advent of titanium as an engineering material has led to the need for precise information on its machining properties. It is true that the metal is as yet available only in small quantities, but if it is to be used at all it will be necessary to machine it, and in the absence of reliable data it would only be possible to proceed on a trial-and-error basis. A considerable amount of information has now been made available on one aspect of machining titanium by the publication of the Report "Drilling Titanium Alloy Ti 150A," which has been prepared by the Production Engineering Research Association of Great Britain, Staveley Lodge, Melton Mowbray, Leicestershire. The object of the investigation described in the Report was to determine the effects of drill point shape, helix angle, cutting speed, feed rate and cutting fluid on the performance of high-speed steel drills when drilling the alloy in question. As a result of the investigation it has been possible to formulate some important rules for drilling procedure; these are detailed in the Report.

For the purpose of the investigation, holes were drilled in test specimens ¾ in. long parted-off from 2-in. diameter titanium bars. The drill size chosen was 0·323 in. in diameter (letter P), in order to provide a suitable core diameter for a subsequent tapping investigation. Through holes were drilled in all cases, except where the drill failed before this could be done. The test criterion was drill life, expressed as the total depth of hole drilled before the drill failed and needed re-grinding, a condition which was shown immediately by a loud screeching and a sudden increase in drilling thrust. Analysis of the test material showed it to have a chemical composition of: carbon 0·05 per cent., iron 1·48 per cent., nitrogen 0·10 per cent., chromium 2·75 per cent., titanium the remainder.

TEST PROCEDURE

The specimens were drilled in a special portal frame drilling machine (Fig. 1), which consists of a drilling head mounted in a rigid frame and driven by a 7½-h.p. motor through V-belts. Eighteen speeds from 30 to 1,500 r.p.m. and 18 feeds from 0·0006 in. to 0·048 in. per revolution are available. Cutting fluid is delivered through an annular distributor having eight nozzles (Fig. 2). Specimens were clamped to a torque and thrust dynamometer mounted on the bed of the drilling machine.

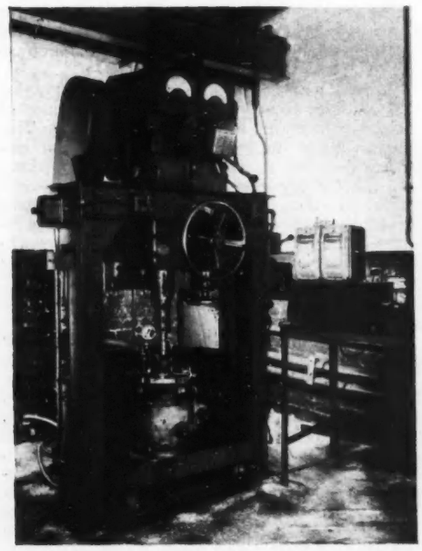


Fig. 1 Special drilling machine, with thrust and torque dynamometer.

Fig. 2 Cutting fluid is delivered through an annular distributor.

The dynamometer consists of a body, table and inner sleeve, the latter being spigoted and bolted to the underside of the table to form a single assembly. This is supported by a thrust pin and is located in the body by roller races. It is thus able to rotate and to float axially within the limits imposed by two stiff steel diaphragms mounted on knife edges. As the test specimens are clamped to the table, torque and thrust set up by the drilling are transmitted to the two diaphragms. Deflections of these components are amplified electronically and recorded by a pen recorder. The dynamometer is shown in Fig. 3, and it can also be seen in the illustration of the drilling machine (Fig. 1).

As the investigation was also concerned with the shape of the drill, a special instrument developed by PERA was used to examine the drill points. It is shown in Fig. 4. The instrument can be used to measure the relief angle, point angle, and relative lip height. For measuring the relief angle the drill, mounted in a V-block, is positioned with its axis perpendicular to a fixed cross-wire in the microscope. The eye-piece, which can be rotated, is set at zero on the 360-deg. protractor, and the drill is rotated in the V-block until the image of its outer corner coincides with the centre mark on the cross-wire. The eye-piece is then rotated to align the cross-wire with the image of the intersection of the drill land and flank, and the relief angle at the outer corner is read directly from the protractor scale.

The point angle is measured by viewing the cutting edges through the microscope and reading the angle on the protractor.

The relative lip height is measured by moving an adjustable cross-wire in the microscope eye-piece to coincide with the image of the drill outer corner. A reading is then taken on the calibrated dial which controls the position of the cross-wire. The drill is then rotated through 180 deg., axial movement being prevented by a stop at the shank end, and the adjustable cross-wire is again moved to coincide with the image of the drill outer corner. The difference between the readings on the calibrated dial at the two settings is the relative lip height.

The effects of altering the various angles on the drill were marked, and since the recommendations give specific figures, the Report includes a diagram showing the nomenclature adopted. This diagram is reproduced in Fig. 5.

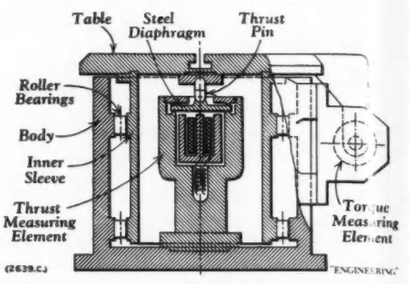


Fig. 3 Dynamometer, registering torque and thrust through steel diaphragms and electronic amplifiers.

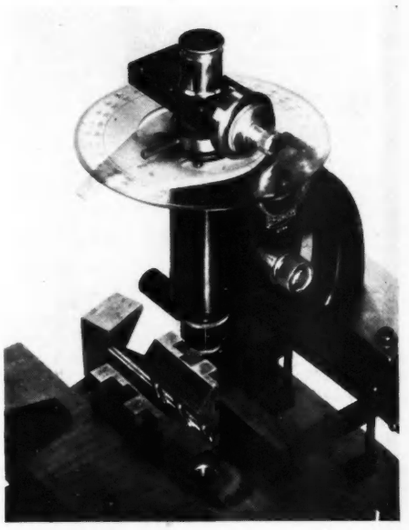


Fig. 4 PERA drill-point inspection instrument.

Numerous tests were carried out, using different cutting speeds and feed rates, helix, point and relief angles, and various cutting fluids. Tests were also made to see if titanium work-hardens during machining. For this purpose, Vickers diamond-pyramid readings were taken on the walls of holes, both where the drill had failed and where drilling had proceeded satisfactorily.

RESULTS

The Report sets out the results of the series of tests graphically, and draws several important conclusions from the data presented. It was found that superior drill life resulted when the point angle was 105 deg. and the relief angle was 10 deg. The lowest drilling torque was obtained when the point angle was 105 deg. and when the relief angle was 10 deg. the thrust was 80 lb. less than the average figure obtained for the three other relief angles tried. Superior drill life, lowest torque and lowest thrust were recorded when using a cutting speed of 64 ft. per minute and a feed rate of 0·0014 in. per revolution. Speeds and feed rates above these figures resulted in a marked deterioration in drill life. Different cutting fluids also had a noticeable effect, and it was found that the best drill life was obtained when using a fluid consisting of one part of mineral oil and five parts of soluble oil diluted with eighteen parts of water. This also gave the lowest torque readings, but the lowest thrust was obtained with sulphurised neat oil as a cutting fluid. When using the 1 : 5 : 18 cutting fluid described, drill life was ten times greater than when using sulphurised neat oil, and forty times greater than with soluble oil at 1 : 20 dilution.

Drill helix angle also proved important. An angle of 25 deg. gave the best drill life and the lowest torque and thrust readings. In drilling titanium the most severe conditions occur when

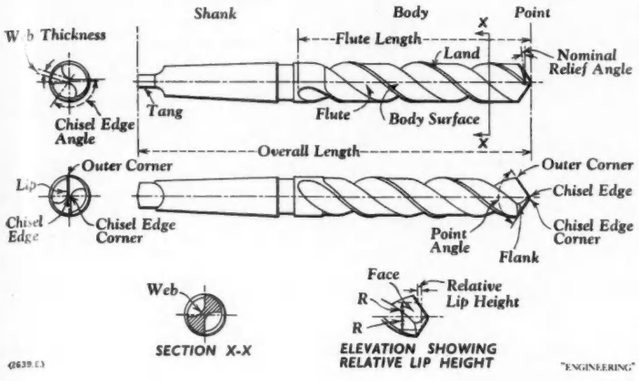


Fig. 5 Diagram of drill nomenclature.

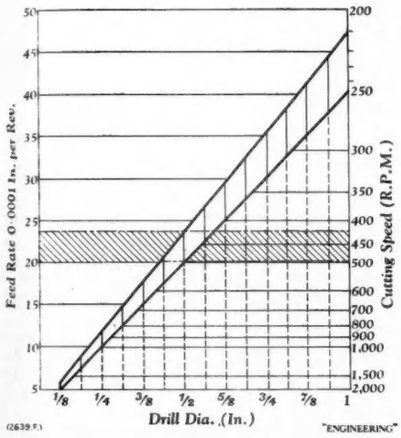


Fig. 6 Speeds and feeds for holes from $\frac{1}{8}$ in. to 1 in. diameter. The cross-hatching slows the drilling speed and feed rate for a $\frac{1}{2}$-in. drill.

breaking through the bottom of a hole, and it is considered that longer drill life will result when drilling blind holes. The Vickers hardness tests showed very little variation across the sectioned holes, and micro-hardness readings also gave no indication of work-hardening.

RECOMMENDATIONS

The experiments showed that the following recommendations could be made:

(1) The drill point angle should be 105 deg.
(2) The relief angle should be 10 deg.
(3) The helix angle should be about 25 deg.
(4) The cutting speed should be approximately 60 ft. per minute.
(5) The feed rate should be 1 in. per min.
(6) The cutting fluid should be one part of mineral oil SAE 20, five parts of soluble oil, and eighteen parts of water. The mineral oil should be mixed with the soluble oil and then added to the water.
(7) A copious supply of cutting fluid should be provided through an annular distributor.

It is also suggested that the tests can be used as a basis for determining cutting speeds and feeds for holes from $\frac{1}{8}$ in. diameter to 1 in. diameter, and a graph, Fig. 6, has been prepared accordingly.

★ ★ ★

ROAD RESEARCH LABORATORY

Open Days

The Road Research Laboratory is to hold Open Days this year at both the Materials and Construction Division at Harmondsworth, Middlesex, and the Traffic and Safety Division at Langley, Bucks. The dates fixed are Thursday May 12, and Friday, May 13. The Scottish Branch of the Laboratory, at Thortonhall, near Glasgow, will be open on June 2 and 3.

COMBUSTION INDICATOR FOR BOILER HOUSES

Instrument for Checking Flue-Gas Losses

A new form of instrument which enables a boiler-house fireman to see at a glance whether or not the combustion conditions are satisfactory has been introduced recently by Kelvin and Hughes (Industrial), Limited, 2 Caxton-street, London, S.W.1. The instrument is known as the Econometer and as will be seen from the illustration below is of the edgewise pattern with two vertical illuminated scales, one on the left indicating the flue-gas temperature and one on the right showing the percentage of CO_2. The scales are graduated on the edges of slots, which have translucent material behind them, and the readings are taken from the upper end of a dark shadow which is moved by the instrument mechanism leaving the upper part of the slot brightly illuminated. The instrument was not in use when the photograph was taken from which our illustration has been reproduced.

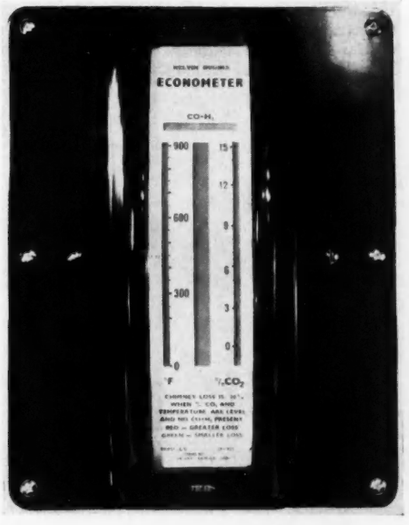
COMBUSTION CONDITIONS SEEN AT A GLANCE

Between the temperature and CO_2 scales is another vertical slot of the same length and above them is a shorter horizontal slot. The latter is coloured amber and normally is not illuminated, but when unburnt gases, that is, carbon monoxide and/or hydrogen, are present in the flue gas up to a maximum of 1 per cent. an amber light shows. Half illumination of the slot indicates the presence of $\frac{1}{2}$ per cent. of unburnt gas, this being the upper limit for reasonable economy. The central vertical slot is probably the most useful part of the instrument. In the lower part of this slot a dark shadow appears, the upper limit of which is pre-set to a position corresponding to the calculated optimum flue-gas heat losses for the plant, and remains in that position. If the losses exceed this figure a red band appears in the space above the shadow, the length of the band indicating the excess of the loss and thus the extent of the drop in combustion efficiency. Similarly, a green band appears if the losses are of less than the optimum value. The coloured bands are, of course, due to the CO_2 and temperature readings in combination, a green band appearing with a rise in CO_2 or a fall in temperature and vice versa; they are, however, discounted when an amber light is showing in the upper horizontal slot due to the presence of unburnt gases. In practice, therefore, it is only necessary for the fireman to keep the green band showing and the amber light extinguished to be sure that the combustion conditions are satisfactory.

METHOD OF MEASURING UNBURNT GASES AND CARBON DIOXIDE

The temperature measurements are obtained from a thermocouple inserted in the stack and the gas analyses are carried out electrically on a continuous sample drawn off by a simple aspirator. The sample is first passed through a CO and H_2 analysing chamber from which a part of the gas diffuses into the measuring chamber where it is burnt on a heated platinum wire. This wire forms part of a Wheatstone-bridge circuit which also includes a similar heated wire exposed to the atmosphere. The catalytic combustion of the gas on the one wire increases its temperature, and consequently its resistance, thus disturbing the balance of the bridge and giving an indication on a millivoltmeter the movement of which controls the amber light. The gases leaving the analysing chamber are passed through another chamber in which all the hydrogen is oxidised by catalytic action leaving only CO and CO_2. A minute sample of this mixed gas is diffused into a measuring chamber in which its thermal conductivity determines the temperature of a heated platinum wire in a bridge circuit, which also includes a heated wire exposed to the air. As the gas conductivity is affected only by the CO_2, and not at all by the CO, the unbalance of this bridge is an accurate measure of the percentage of CO_2 present, and can be used for the direct indicating scale of the Econometer as well as for controlling the coloured band in the central slot. The necessity for burning out any hydrogen present before subjecting the mixed gas to the conductivity measurement will be apparent when it is remembered that the thermal conductivity of hydrogen is about seven times that of air, so that the presence of a small proportion of the former gas would invalidate the CO_2 measurement. The thermal conductivity of CO_2, is about 0·6 that of air.

The apparatus is housed in a robust rectangular case of cast light-alloy which is proof against both fumes and moisture, removable covers being provided to give access to the components. As previously mentioned, it is designed primarily for panel mounting, but can be wall mounted if desired. It is operated from a 50-cycle mains supply within the ranges 110 to 125 or 200 to 250 volts, and the consumption is about 40 watts. Each of the three sensitive high-resistance indicators employed is of the moving-coil type and is fitted with a magnetically-suspended coil assembly designed to reduce the effect of shock and vibration to the minimum. Simple zero-setting adjustment is provided on the front plate for the temperature and CO_2 movements.



Instrument giving continuous indication of chimney losses from boiler plants. Red or green bands which appear in the central slot show the fireman the extent by which the losses exceed or fall below the optimum.

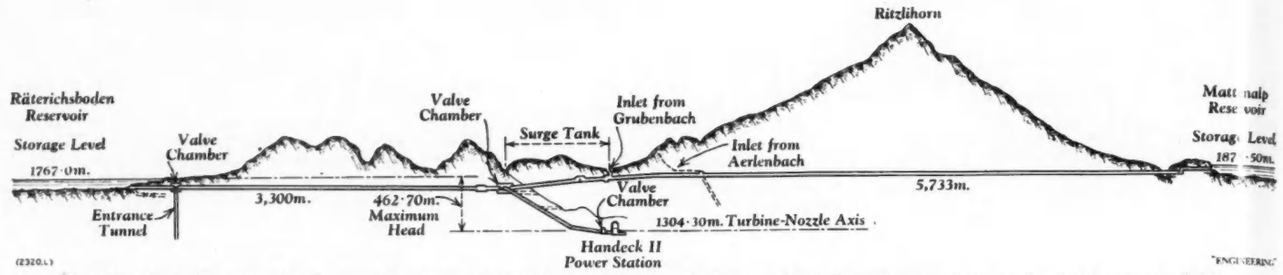


Fig. 11 Vertical section showing supplies to Handeck II power station which was also built underground as no level site was available.

OBERHASLI POWER SCHEMES

POST-WAR DEVELOPMENTS AND DISTRIBUTION SYSTEM

Concluded from page 16

RÄTERICHSBODEN RESERVOIR

The construction of Handeck II power station was made possible by tapping sources of water additional to those which serve Handeck I, the most important being the Räterichsboden reservoir, which has a capacity of 27 million cub. m. of water. It is supplied by the waters of the River Aare, as it issues from Grimsel Lake, and also by various mountain streams (see map, Fig. 1, page 13, *ante*). The entire subsurface of the area covered by the reservoir is composed of hard impervious granite. As the River Aare flowed across the site it was diverted to a tunnel 390 m. long; this was provided with an intake and gate so that it could subsequently be used for draining the reservoir. The gate is situated immediately below the intake to the feeder tunnel leading to the power station. In addition, two roads had to be diverted.

The Räterichsboden dam is a concrete gravity structure 456 m. long at the apex and 93 m. high from the lowest point of the foundations. It contains approximately 278,600 cub. m. of concrete. It was built in three parts, that at the centre being 226 m. long, and the western and eastern parts being 87 m. and 143 m. long respectively. The structure is divided into vertical sections by contraction gaps at 18 m. centres, and has three inspection galleries, situated behind the upstream face, which are accessible through a shaft leading from the top of the dam. A fourth gallery near the toe is accessible from the drainage pipe on the downstream side. A rich concrete mixture was employed for both faces of the dam and the crown was finished with granite blocks. The spillway, situated towards the western end of the centre section has a capacity of 105 cub. m. per second.

MATTENALP RESERVOIR

The Mattenalp reservoir, the second source from which Handeck II power station is supplied, collects water from sources which were untapped when the Handeck I and Innertkirchen schemes were carried out. The catchment area extends over 36 sq. km., two-thirds of which are covered with ice. The amount of water carried by the streams varies greatly with the seasons and contains much silt and rubble. Topographical conditions did not permit the construction of a large storage reservoir, although that would have been the most satisfactory arrangement from the point of view of continuity of supply to Handeck II. The dam built actually impounds about 2 million cub. m., and the reservoir formed is sufficiently large to take the silt carried by the streams and to act as a regulating pond during peak water supplies. The total length of the gravity dam is approximately 100 m.

Before starting work on the foundations of the dam, the Urbachwasser was diverted to a conduit leading to a tunnel some 280 m. long, now part of the main feeder line to Handeck II power station. At its entrance there is a submerged intake structure, which can be used when desired for draining the reservoir. At the other end there is a spillway structure and valve house. The submerged intake structure contains a 1·2 m. diameter sluice valve which is opened when it is desired to drain the reservoir. Close to the entrance to the tunnel there is an underground chamber containing a 1·1 m. diameter butterfly valve controlled from the power station. Access to the valve chamber is provided by a vertical shaft.

The main feeder tunnel connecting the spillway structure with the Handeck II surge chamber is 5,733 m. long and is designed to carry 15 cub. m. of water per second. It is of horseshoe form with a cross-sectional area of 7 sq. m. The floor is of concrete with an elevated path at one side, and two conduits carry telephone lines and cables for the remote control both of the valves in the underground valve chambers and the valve and gate in the spilling chamber.

Between the Mattenalp reservoir and the surge chamber, the tunnel receives the water of two mountain streams, the Aerlenbach and the Grubenbach. The glaciers in which these streams rise are indicated in the map, Fig. 1. The tunnel between the intakes of these streams is circular in section, and not of the horshoe form used for the greater part of the length. This circular section, on a slope of 7·5 per cent., terminates in a desilting and pressure-equalising chamber of 500 cub. m. capacity. The outlet from the chamber to the penstock is provided with a fine rack. Both streams are directed into open flumes provided with trash racks which trap all bodies 4 cm. or more in diameter. Beyond the rack there are 200-cub. m. capacity desilting chambers excavated in the rock. Flushing arrangements are provided to clear the chambers periodically.

As will be seen from the section (Fig. 11, above) the feeder tunnels from the Räterichsboden and Mattenalp reservoirs meet in an underground valve chamber at the head of the Handeck II penstock. The regulating equipment of the power-station turbine nozzle ensures that the maximum fluctuation in water consumption does not exceed 1 cub. m. per second.

In the event of the turbines being suddenly shut down, there would be a pressure rise in the penstock, the pressure wave being propagated until it reached the open surface at the top of the surge tank, when it would be reflected and return, the time occupied in the double journey being about 2 seconds. The pressure at the lower end of the penstock would rise to the equivalent of a water column from 40 to 50 m. high and at the upper end to one of 10 m. The feeder tunnel from the Räterichsboden reservoir is provided with a butterfly valve, 2·7 m. in diameter, which closes automatically in the event of a sudden station shut-down, the speed of closing being such that no dangerous pressure rise will occur in the tunnel behind it. After a sudden shut-down there will be two masses of oscillating water, one being that trapped in the penstock and surge chamber and the other in the Grubenbach intake and the surge chamber; the pressure waves of these moving masses will not coincide and the motions will be gradually damped out.

The length of the penstock from the underground valve chamber to the branch to the first turbine in Handeck II is 866 m., and the difference

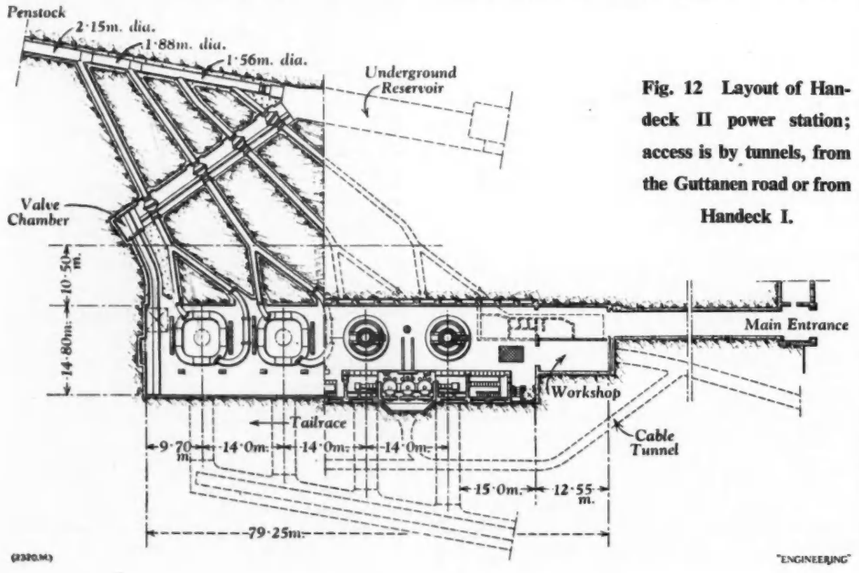


Fig. 12 Layout of Handeck II power station; access is by tunnels, from the Guttanen road or from Handeck I.

in level is 376·6 m. The pipes are of Siemens-Martin steel, the internal diameter of the upper section being 2·25 m. and that of the lower section 2·15 m. The wall thickness is 11 mm. at the upper end and 12 mm. at the lower. The tunnel in which the penstock is contained was driven through compact granite, and in the upper part the pipes were embedded in concrete, poured from above; lower down the concrete was forced into place by a pump. In all cases pressure grouting ensured good contact with the rock formation. The pipes were supplied in lengths ranging from 7 to 10 m., which were welded together on site as they were introduced into the tunnel. The inner surfaces of the pipes were sandblasted, sprayed with zinc and finished with a coating of bitumen.

HANDECK II POWER STATION

Handeck II power station, like Innertkirchen, is underground as the topographical conditions of the entire area were such that it was not possible to find a site suitable for the erection of a building; levelling and clearing would have been impracticable. The rock in which the station was excavated is hard and compact and the minimum cover is 20 m. A layout is given in Fig. 12 opposite. The turbine discharge channels connect to an underground equalising reservoir with a capacity of 50,000 cub. m.; this in turn connects to an outdoor equalising pool with a capacity of 32,000 cub. m. From this pool, connection is made at a point below Handeck I to the Innertkirchen feeder tunnel. The pool is provided with an overflow to the river and also with a connection by which it may be drained. Access to the interior of the station is obtained by an underground passage 156 m. long, connecting with the Guttannen road. There is also an underground passage way connecting Handeck II with Handeck I, and so giving access to Guttannen village by means of the underground rail car previously mentioned.

The station is designed to accommodate four generating units, as shown, but up to the present only two have been installed. Independent connection for each turbine is made to the penstock. The side branches are 1·1 m. in diameter, the wall thickness being 16 mm. at the penstock end increasing to 26 mm. at the valve end. The valves are of the rotary-piston type embodying emergency and control pistons. The emergency section may be closed to permit inspection or repair of the control valve. Each combination is equipped with a Venturi meter and the valves are remote-controlled from the station operating board.

The lowest of the three floors carries the turbine casings which rest directly on a rock foundation. As the alternators are mounted directly on the turbine casings, the alternator floor does not carry any substantial weight. It accommodates small transformers for local service, storage batteries and other auxiliary apparatus. In addition to the control panels the upper machine-hall floor also carries the main transformer bank. The rough-excavated curved roof was finished with a layer of cement concrete about 40 cm. thick resulting in a pleasing finished appearance. The walls were finished with concrete-slabs.

A section of one of the two generating sets is given in Fig. 13, on this page. The turbines were supplied by Escher-Wyss and the alternators by the Oërlikon Company. The turbines, of the vertical Pelton-wheel type, have an output of 32,700 h.p. at 390 m. head and 42,300 h.p. at 460 m. head. The wheels are served by two jets and the speed is 300 r.p.m. The turbine runners, which have 22 buckets, are single-piece steel castings weighing approximately 16 tons and the main turbine bearing is 600 mm. in diameter. Speed control of the machines is effected by adjustment of the needle as well as deflection of the jet; details of the mechanism are shown in Fig. 14, on page 52.

The speed-control arrangements consist of a pendulum generator, with permanent magnet excitation, carried at the top of the main alternator shaft and a control mechanism situated on the turbine floor. The turbine needles are controlled by servomotors which are operated, either for opening or closing, by oil pressure. These two servomotors are mechanically connected to the jet-deflector servomotor in such a way that the needles and the deflectors operate in unison. The jet-deflector servomotors are operated by oil pressure when moving to increase the speed of the turbine and by water pressure, obtained from the main supply, when moving to reduce speed.

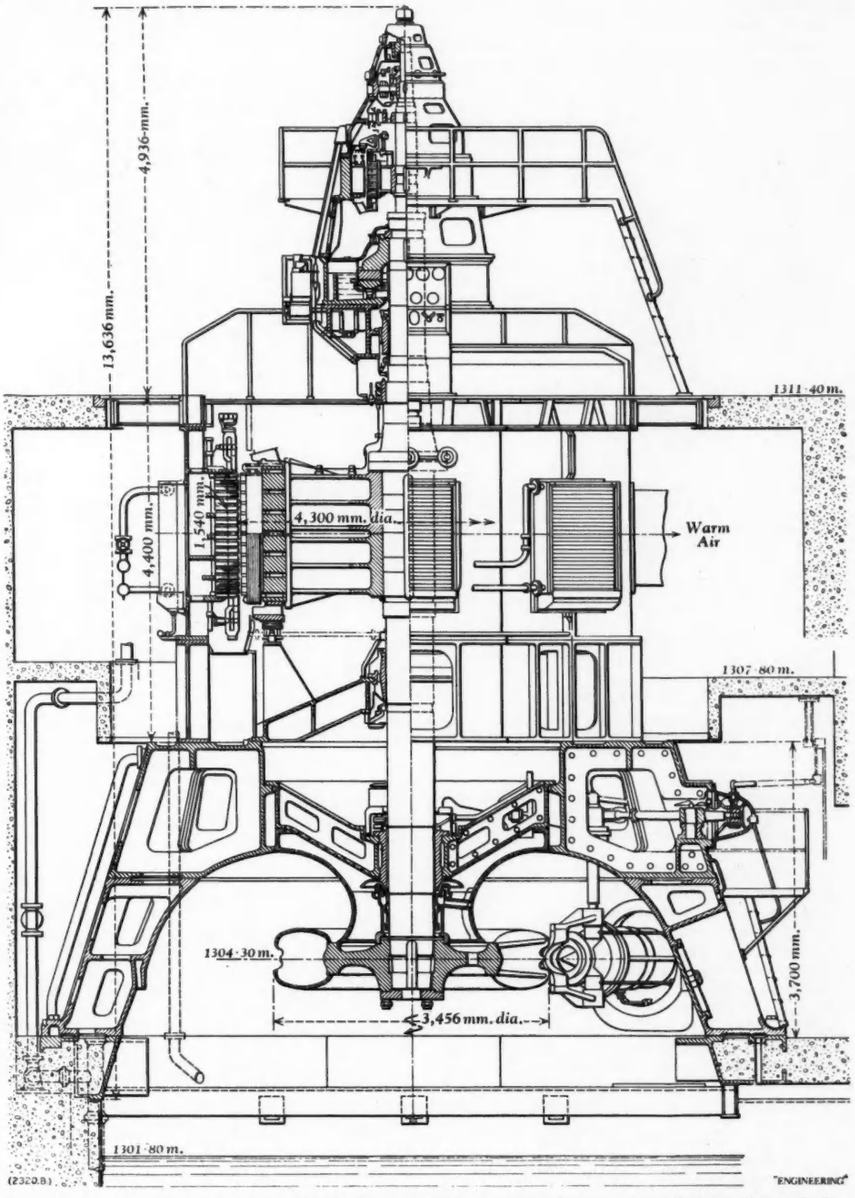


Fig. 13 Section of one of the Escher-Wyss Oërlikon generating sets installed in Handeck II power station. At 300 r.p.m. it is rated to give 40 MVA at 13·5 kV.

The alternators are rated at 40 MVA and generate at 13,500 volts, 50 cycles. The running speed is 300 r.p.m. and the runaway speed 550 r.p.m. As will be seen from Fig. 13, the rotor shaft carries the turbine runner at its lower end. The stator, the base of which is octagonal, rests on a welded-steel frame interposed between the stator and turbine casings. In this way the total weight of the generator, 245 tons, is transmitted directly to the rock foundation. The braking equipment consists of oil-operated rams which can bring the machine to rest from full speed in five minutes. The same rams can be used to lift the rotor about 2 cm. to enable the thrust bearing to be inspected.

The rotor shaft is made up of three sections as may be seen from Fig. 13. The main reason for this is that the headroom in the underground station was not sufficient to permit the handling of a full-length shaft. Voltage regulation of the main generator is effected by a shunt circuit on the main exciter, connected through automatically-adjustable resistances. The automatic voltage regulation is controlled by an Oërlikon oil-pressure regulator which moves the commutator brushes, the commutator segments being connected to the various sections of the regulating resistance. At the top of the shaft there is a centrifugal switch which comes into operation if the speed exceeds or falls below pre-determined limits.

The main generator is cooled by air circulated by fans mounted on the shaft. Part of the heated air may be diverted into the station if desired. The bearings are equipped with thermo-couples and similar instruments are fitted in four slots of the stator winding and at other points to measure the temperature of the circulating

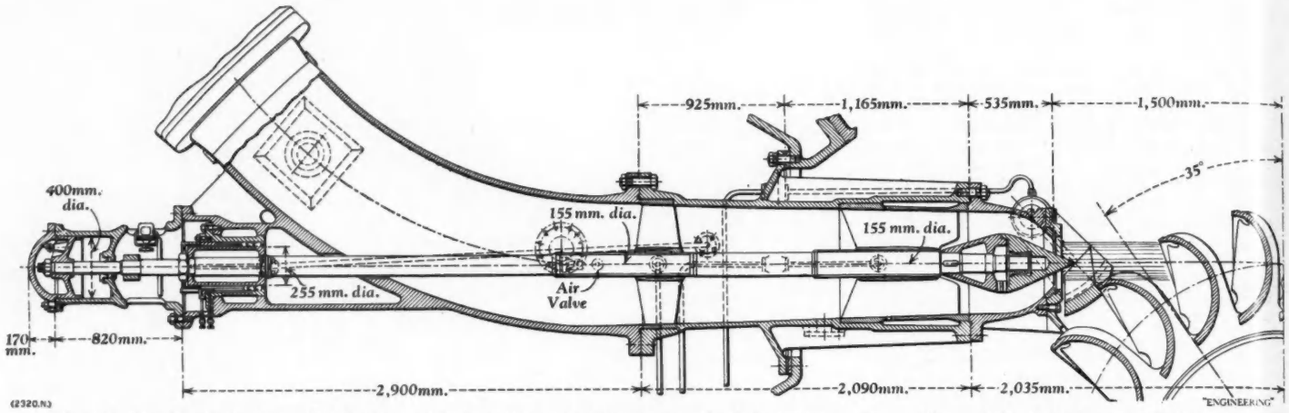


Fig. 14 Details of the jet and deflector mechanisms for controlling the speed of the turbine. The needle and the deflector operate together.

air. The readings are shown on the main instrument panel. The temperatures of the oil and cooling water are indicated on a panel fixed on the set. Instruments indicating the oil circulation are connected to pilot lamps and acoustic warning signals.

The two generating sets are connected to a common transformer bank of 80 MVA capacity. It consists of three single-phase delta-star Brown-Boveri transformers stepping up the voltage from 13·5 kV to 150 kV. The transformer chamber is provided with a steel lattice blind and can be completely isolated from the machine room in case of fire; arrangements are also provided for forcing carbon-dioxide gas into the chamber. The transformers are arranged for forced oil and water cooling. The high-tension side of the bank is connected to 150-kV oil-filled cables laid in the tunnel leading to Handeck I power station. The 13·5-kV switchgear consists of two air-blast circuit breakers, one for each alternator, together with the usual current and voltage transformer relays and measuring instruments, and the compressed-air plant for operating the breakers.

The station auxiliaries include a horizontal Pelton-wheel turbine, supplied by Escher-Wyss, driving a 600-kVA Secheron alternator generating at 380/220 volts, with a step-down transformer for local services. There is also a 310-ampere-hour stand-by storage battery. The underground station is lighted by fluorescent lamps and a Sulzer ventilating plant supplies 40,000 cub. m. of fresh air per hour through the entrance tunnel.

GRIMSEL STATION

The construction of the Grimsel station is now complete, and it has been in operation since July, 1954. The object of the plant is to increase the winter output of the Oberhasli power stations by pumping water from the Grimsel Lake into the Oberaar reservoir during the summer months and to use the water thus stored in winter when the supply is scarce. The Grimsel station, which is an underground structure, contains a vertical pumping unit and a generator set, and is located below the Spitallamm dam, about 350 m. lower down the valley. A tunnel 2·3 km. in length, which is used for draining purposes and also contains the power and other cables, connects the Grimsel station with a switching station at Gerstenegg, close to the Räterichsboden dam, which latter is connected by an aerial ropeway with the Handeck I station. A second tunnel connects the Grimsel station with the instrument chamber of the Spitallamm dam. The disposition is shown in Fig. 1. The Oberaar reservoir has a capacity of 58 million cub. m. and is located at the foot of the Oberaar Glacier. It is supplied from a catchment area of approximately 20 sq. km., with a run-off during the summer months of 38 million cub. m. In order to fill the reservoir, 20 million cub. m. have to be pumped up from the Grimsel Lake. The winter run-off of the district is only 1·9 million cub. m. The small Trübten Lake, to the east of the Oberaar reservoir, has a capacity of 1·0 million cub. m. The operation of this plant will give a total yearly increase of approximately 30 million kWh from the other stations.

The Oberaar dam is a concrete gravity structure. The greatest height is 105 m. A tunnel, 2·6 m. in diameter and 4·55 km. long, connects the Oberaar reservoir with the surge chamber, the discharge being 7·5 cub. m. per second. The armoured penstock connecting the surge chamber with Grimsel station has a diameter of 1·65 m., the entire length being 1·6 km. The storage pump in the station, made by Sulzer Brothers, has a capacity of 4 cub. m. per second against a 400-m. delivery head and is driven by a 29,000-h.p. Brown-Boveri asynchronous motor running at 1,000 r.p.m. The unit is vertical with the pump mounted under the motor, this arrangement facilitating inspection and repair of the pump. The pump is started and stopped by an attendant, but control while in operation is from Innertkirchen.

The power generating group is formed by a horizontal three-phase 45-MVA generator running at 375 r.p.m. and two overhung Pelton wheels of 21,000 h.p. each. Current is generated at 13,500 volts 50 cycles. The horizontal arrangement has the advantage of easy access to all vital parts, since these are all above the turbine floor. Normally, both turbines are in operation together, but in case of any difficulty with one Pelton wheel, the other can still be kept running.

The generator is connected to a group of three single-phase transformers, the voltage being stepped up to 150 kV. An oil-filled 150-kV cable connects the high-tension side of the transformer with the switching station at Gerstenegg. The cable is laid in the 1·6-m. diameter tunnel mentioned above. This station is connected to Handeck by an overhead line 3·1 km. in length. Like the pump, the turbine-generator set is remote controlled from the control room of the Innertkirchen station.

The table given below shows the total annual production of the Oberhasli stations. The figures represent the minimum output in a year of low precipitation. It is stated that under favourable conditions the total output of the stations will exceed 1,300 million kWh and will, of course, be further increased when the last two units are installed in Handeck II.

Power Station	In Operation Since	Output Capacity (kVA)	Annual Production, (million kWh)		
			Summer	Winter	Total
Handeck I	1932	4 units at 28,000	132	148	280
Innertkirchen	1943	5 units at 52,250	470	205	675
Handeck II	1950	2 units at 40,000	148	97	245
Grimsel	1954	1 unit at 45,000	−190	220	30
			560	670	1,230

TRANSMISSION AND DISTRIBUTION

The power supply of the whole Oberhasli scheme is controlled by an outdoor switching station situated near Innertkirchen from which transmission lines radiate. The station has undergone considerable extension and modification since it was built to control the supply from Handeck I, the first station to go into operation. When the Innertkirchen station supply became available, two further outgoing lines were added and these were controlled by low oil-content circuit-breakers supplied by Sprecher and Schuh of Aarau.

When Handeck II came into operation, connection was made to the switching station bus-bars by a 150-kV line controlled by a Sprecher and Schuh oil circuit-breaker. At the same time, two 11/50-kV transformers at Handeck I power station were replaced by a single 11/150-kV transformer bank with Brown-Boveri air-blast circuit-breakers on the 11-kV side. Two new 150-kV feeder lines carried on steel-frame towers, were erected between Guttannen and the switching station, controlled at the switching station end by Sprecher and Schuh oil circuit breakers. Two of the Handeck I units continue to supply the switching station at 50 kV through step-up transformers at the delivery end, but it is intended that these lines shall be changed over to 150 kV at some future date. With the coming into operation of Handeck II, two further outgoing lines were added at the switching station and the most recent addition is the line from the Grimsel station.

A view of the switching station with a Sprecher and Schuh low oil-content circuit-breaker in the foreground is given in Fig. 15 opposite. Of the outgoing lines four are controlled by breakers of this type and two by Brown-Boveri air-blast breakers. Each pole of the Sprecher and Schuh breakers consists of two porcelain columns connected by a metal junction piece The upper interrupter column contains the contact mechanism and the lower provides insulation from earth. The upper column is oil filled, but the lower contains oil only when a current transformer is fitted. The actuating mechanism at the top of the upper column is operated through a small side column, also built up of two porcelain insulators connected by a metal junction piece. The operating columns connect at their lower ends to a driving shaft which extends across the front of the breaker and is operated by the tripping and closing mechanism contained in a weatherproof pillar at the side of the breaker. This general arrangement is clearly shown in Fig. 15.

When the breaker trips, the contact rod moves

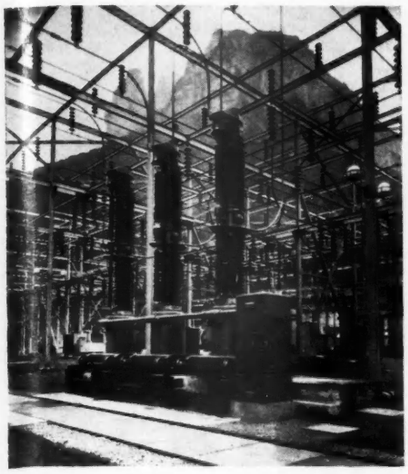


Fig. 15 Sprecher and Schuh 150-kV circuit-breaker at the main switching station.

upwards at a high speed and an arc surrounded by a gas bubble is formed at its lower end. As the end of the rod enters the quenching chamber the length of the arc continues to increase, but since the oil surrounding the arc is prevented from escaping it is vaporised and considerable pressure is produced. The result is that a mixture of gas and oil is forced into the arc on its passage through zero value, and cooling and de-ionisation are sufficiently great to prevent it reforming. The duration of the arc is approximately 0·03 to 0·05 second and the total breaking time 0·9 second. The operating mechanism in the weatherproof pillar consists of a spring wound by an electric motor, but the spring can be wound manually by a crank handle if necessary. Closing and tripping are normally by remote control but may be operated by hand.

* * *

TUBULAR VIBRATOR CONVEYORS

Handling Hot or Dusty Materials

Vibrator conveyors have a wide range of application in industry and can be used where belt conveyors are not suitable. Those made by Owl Engineering Supplies, Limited, 16 Southparade, Doncaster, are of two types, with open troughs and closed tubes respectively. The latter are particularly suitable for handling materials which are unpleasant or may give rise to dust, for with them the whole conveyor system can be kept completely enclosed. Two examples are illustrated below.

Vibrations are imparted to the tube by two totally-enclosed electric motors coupled by a gearbox. This assembly can be mounted either above the tube, as shown in Fig. 1, or below it, according to circumstances. The articulated laths which couple the tube to the fabricated steel base compensate for the tractive forces and pressure strains, confining the vibrations to the tube. Although both illustrations show the units mounted on the floor, it is equally possible to suspend them from above.

Material for transport can be delivered to the tube at any point along it, as is shown in Fig. 2. This conveyor is installed in a power house for the removal of hot ashes from the furnaces. With an 8-in. diameter pipe, it can handle about 0 tons of ashes per hour. Powders can only be conveyed horizontally or downhill, but some materials can be moved upwards at angles up to 20 deg., depending on the material, the maximum angle usually being determined by trial. Fig. 1 shows a conveyor for this purpose assembled at the factory. Hot materials at temperatures up to 500 deg. C. can be handled.

The tubular conveyors are available in a range of sizes, with tubes ranging from 4 in. to 18 in. in diameter and up to about 70 ft. long. With the largest size, material weighing 1¼ tons per cubic yard can be delivered at about 140 tons per hour. Tubes can be duplicated for larger discharges. The power required when passing 148 tons per hour along a distance of 28 ft. is 2·2 kW. Open-trough conveyors are also made, with slightly larger capacities, but these, of course, do not prevent dust from escaping into the atmosphere.

* * *

ALUMINIUM IN SHIPBUILDING

Diesel-Driven Lighter for Tropics

A ramped cargo lighter made of aluminium was launched into the River Tees last month from the slip-ways of Head, Wrightson, and Company, Limited, Thornaby-on-Tees. Ramped cargo lighter is the commercial name for naval landing craft, but the use of aluminium has reduced the weight to almost half that of the steel version used in World War II. The lighter has been built to the order of the Fairmile Construction Company, Limited, Cobham, Surrey, and their consulting naval architect was Mr. Sidney Graham, M.B.E., M.I.N.A. Richard Pickersgill and Sons, Limited, Stockton-on-Tees, installed the engines, steering gear and deck equipment.

The vessel is 60 ft. long with a beam of 16 ft.; the weight is about 11 tons; it is a twin-screw vessel powered by twin 75-h.p. Perkins Diesel engines. The aluminium alloy used in the construction is to specification BB3, and was specially chosen for its resistance to sea water corrosion; it is expected that use of this aluminium will keep maintenance costs down. The lighter is designed to transport stone from new gravel deposits at Brunei, North Borneo; it will normally carry 30 tons on a 4 ft. 2 in. draught, and will be lined with timber supplied and fitted in North Borneo. The ramp in the bows allows it to be used for either beach or ramp discharge. A hand operated winch lowers and raises the ramp, and when the ramp is lowered vehicles can be driven on and off the vessel. There is a helmsman's shelter, and an Asian type cookhouse for the native crew.

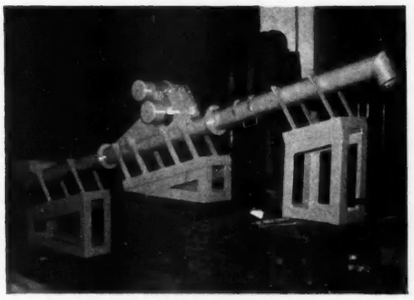


Fig. 1 Tubular vibrator conveyor for uphill transport. The motors which produce the vibrations are mounted above the tube.

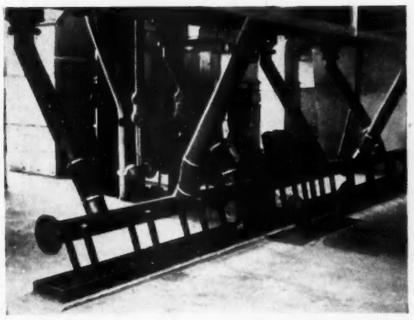


Fig. 2 Conveyor for handling hot ashes from boiler furnaces. There are separate feed pipes from each furnace and the whole system is totally enclosed.

* * *

The silencer should be mounted as close to the fan as possible, and between the fan and the place from which the noise is to be excluded.

SILENCERS FOR FANS

A method of silencing fans without impeding air-flow by baffles or splitters has been introduced by Woods of Colchester, Limited, Braiswick Works, Colchester, an associated company of the General Electric Company, Limited, Magnet House, London, W.C.2. They are designed to work with Woods' Aerofoil fans, and there is a standard range of silencers to accompany the standard range of fans. With one or more of these units the sound emission from the fan can be attenuated to suit the requirements of the installation; it is not necessary to provide acoustic treatment for the ducting.

The silencer consists of two coaxial cylinders, the outer made of plain sheet metal and the inner of perforated metal. The space between the two cylinders is filled with sound-absorbent material. The outstanding feature of the design is the attenuation achieved in the short length of the silencer, about 1½ times the duct diameter; one silencer mounted close to the fan, as shown in the accompanying illustration, will reduce the sound emission by 10 decibels; two in series will make a reduction of 15 decibels, and three will give a reduction of 19 decibels.

To obtain the optimum effect in sound reduction the silencer should be mounted right beside the fan, and between the fan and the place from which the noise is to be excluded, whether upstream or downstream of the fan. In cases where all-round quietness is required, silencers may be fitted on both sides of the fan.

Silencer units are made in six sizes to match Aerofoil fans from 15 in. to 48 in. in diameter. To facilitate direct attachment to the fan the end-rings are drilled and tapped to the same pitch centres as the fixing holes in the fan flanges. A short connecting duct-section with flanges at each end is used where two or more silencers are to be mounted in series. Attachable mounting feet can be fitted, as on the fans. Eye-lugs for slinging are provided on silencers of 30 in. diameter and upwards.

THE ENGINEERING WORKS OF THE TRIPLEX GROUP

LIGHT AND HEAVY FABRICATION, MACHINING AND ASSEMBLY

The Triplex Safety Glass Company, Limited, decided to enter the engineering field in 1950, and in that year the entire share capital of Stern and Bell, Limited, Warstock-road, Birmingham, 14, was purchased. This company operated a general-engineering business at Warstock-road, and had, in addition, a forge and a steel warehouse at Camden-drive, Birmingham, 1. At about the same time, the business of Weldall and Assembly, Limited, which was founded in Birmingham in 1938 and moved to Stourbridge, Worcestershire, in 1945, was acquired. In 1951 the businesses of the Eldair Press Brake and Shear Engineering Company and of Welding Repairs (Birmingham) were added to that of the Weldall company.

FABRICATION, MACHINING AND ERECTION

The oldest of the businesses acquired, that of Stern and Bell, was founded in 1890, and had developed over the years as a light engineering concern which had no specialised product, but was ready to undertake fabrication, machining, fitting and assembly of finished machines to order. Under the new ownership this type of work has been continued and developed, and the forge and steel stockholding business have also been kept in operation.

The Warstock works are now equipped with a full range of modern machine tools, including centre lathes, capstan and turret lathes, drilling, milling, grinding and boring machines. The machine shop ends in an assembly bay, where there are facilities for the erection and testing of larger items of equipment requiring the services of an overhead crane. Typical examples of the work done in this assembly bay are the projectile hoists which are at present being built under contract. These hoists, which are used for raising depth charges from a ship's magazine and delivering them to the ramming platform ready for loading, are assembled and tested in full working order in the assembly bay.

Adjoining the machine shop are the fabrication and light assembly departments. Flame cutting equipment, with a capacity of up to 24 in. thick, is installed here, together with the usual facilities for light fabrication and welding. Sub-assemblies for later erection into complete machines at the Warstock works, or for despatch elsewhere to a customer's order, are produced on benches on the shop floor, according to size. A typical sub-assembly is the winch for ships' davits, which is sent to Weldall and Assembly for incorporation in the davit gear made there for Schat Davits, Limited, London Colney, Hertfordshire. The equipment which is available for erecting, and later testing, these davits is shown in Fig. 4, opposite.

The Warstock works have for many years undertaken the complete manufacture of special-purpose machines; these include machines for stringing tennis rackets, trimming logs for wood-fibre production, tread-cutting for rubber tyres, bar and tube polishing, and steel strip coiling. Many of these machines have been prototypes constructed to a customer's design, but design and drawing offices are maintained at Warstock, and these facilities are available when required to develop a new product. In addition to the work of producing new machines and sub-assemblies, Warstock works are regularly engaged on contract machining and the fabrication of individual components to order.

LIGHT AND HEAVY FABRICATION

The Weldall and Assembly works are the largest of the engineering factories in the Triplex group, covering some 130,000 sq. ft. on a 12-acre site. They are divided into three principal sections, which deal with light fabrication, including the manufacture of pallets; heavy fabrication; and the manufacture of the Eldair range of press brakes and shears. The fabrication range extends from light bench work to complete assemblies weighing up to 30 tons in one piece. Shearing capacity is available up to 12 ft. by $\frac{3}{4}$ in. thick, and flame cutting up to 10 ft. by 5 ft. by 12 in. thick. There are press brakes capable of handling work up to 12 ft. by $\frac{1}{2}$ in. thick. Comparable machining facilities are also available, there being planing machines up to a maximum size of 16 ft. by 5 ft. by 5 ft., and horizontal borers up to 6-in. spindle diameter. Much of this larger-capacity equipment is new, some of it having been installed only in the last few weeks. The machines include a Boehringer planing machine with a 16-ft. stroke, a Graffenstaden 5½-in. horizontal boring machine (which is shown in the illustration above, Fig. 1), and a Union 6-in. spindle borer. This latter machine, which is the latest to be installed in the works, will face up to 67 in. diameter, and bore up to 39½ in. diameter. It has a spindle traverse of 55 in., and has been installed primarily to cope with the increasing volume of press brake production.

Fig. 1 Boring facilities include a Graffenstaden 5½-in. horizontal machine.

Light fabrication is undertaken to customers' requirements on a quantity-production or a "one-off" basis as ordered, and this section of the works also manufactures a range of pallets which are a standard Weldall and Assembly product. They include flat and post pallets, and box-type pallets with conical pressed feet for stacking purposes. In addition, pallets are made in numerous special sizes and shapes to meet individual requirements. Storage racks and shelving of all types are also made in this section of the works. Some four-way pallets are shown in Fig. 2, below.

Heavy fabrication is undertaken to customers' orders, and in this part of the factory much of the work undertaken is naturally on a small-quantity basis. The work in normal production includes such items as large gearboxes, fume-stacks and distillation equipment for the oil-refining industry, electrical transformer tanks, bedplates and components for machine tools. Equipment is installed for both gas and electric arc welding, and for long welds there is a Fusarc welding machine which is mounted on a pivoted arm and has a travel of 26 ft. One of the two bays used for heavy fabrication is shown in Fig. 3.

Davit fabrication is carried out in the heavy section of the factory, and adjoining this section there is an erection bay where the davits are

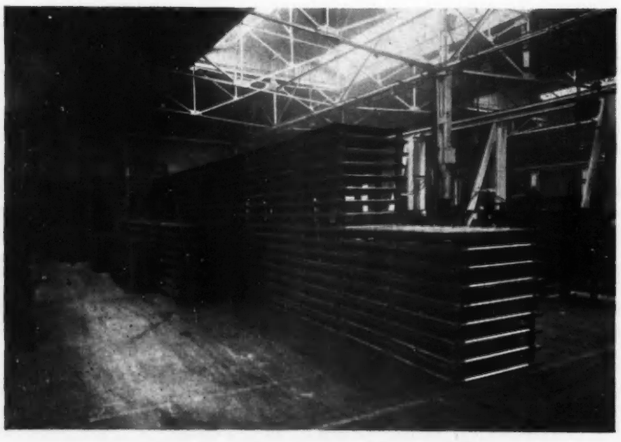


Fig. 2 Typical of the light products are pallets in various sizes of which these four-way units are examples.

Fig. 3 Heavy fabrication is carried out in two bays, one of which is illustrated here.

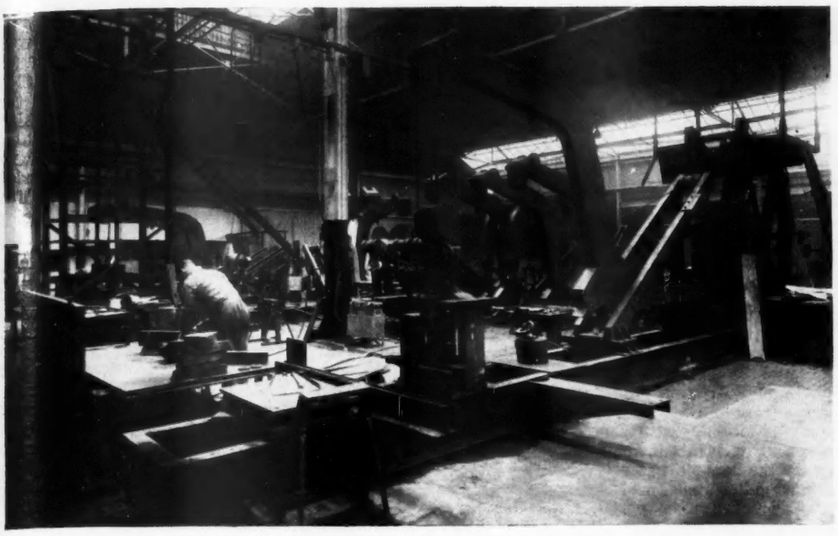


Fig. 4 Full equipment is available for erection and hydraulic testing of ships' davits.

completed and tested by hydraulic loading for deflection. Another type of work which is undertaken in the heavy fabrication section is the manufacture of components for earth-moving machinery, such as dumper and excavator buckets, which are made on a quantity-production basis.

PRESS BRAKE AND SHEAR MANUFACTURE

The production of press brakes and shears has been extended considerably since Weldall and Assembly took over the Eldair business, and the range now includes mechanical press brakes up to 110 tons capacity, with a folding capacity of 12 ft. by ¼ in.; hydraulic press brakes up to 140 tons capacity and capable of folding material 12 ft. by $\frac{1}{16}$ in.; shearing machines up to 8 ft. by ⅜ in. capacity; and alligator-type shears for scrap cutting. The press brakes are of all-fabricated construction, with power-operated adjustment for the top beam. A multi-plate friction clutch or a pneumatic clutch can be fitted as desired, and the control can be by hand or foot. Lubrication is centralised, and is operated on the " one-shot " system.

The range of scrap shears extends from the Eldair " Cub," which can cut ¾ in. diameter bars, 6 in. by ¼ in. flats, 3 in. by ½ in. flats and 1½ in. bore gas pipes at 40 strokes a minute, to a heavy model mounted on wheels, which will deal with ¾ in. plate, 1¾ in. squares, 2 in. diameter rounds and 6 in. diameter pipes. Crushing jaws are incorporated in the ends of the shears for crushing pipes and thin stock prior to cutting. All the shears can be supplied with electric motor, petrol engine or Diesel engine drive as required.

* * *

GENERATING SETS

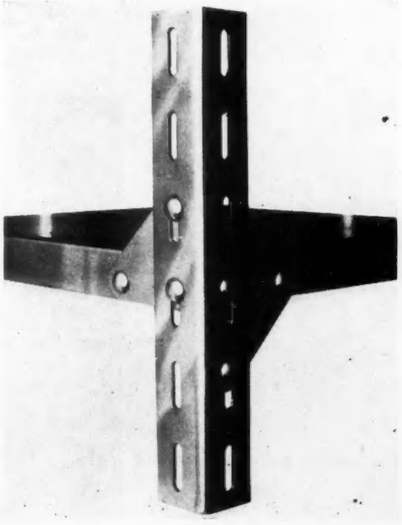
A new range of generating plant has been introduced by Dale Electric (Yorkshire), Limited, Filey, Yorkshire, incorporating the new Ruston series of engines. The range, which extends up to 90 kVA, includes the following sets and engines:—3·5 and 7-kVA sets, Ruston Y.B. engine; 17, 27, 35 and 55-kVA sets, Ruston Y.C. engine; 75 and 90-kVA sets, Ruston 5 and 6 Y.E. engines, respectively.

All the sets are of monobloc construction, the switchboard being an integral part of the complete unit. The 3·5-kVA and 7-kVA are offered as automatic, semi-automatic or hand-starting sets, and the remainder, from 17 to 90-kVA, can be arranged for remote push-button control, normal electric starting or for mains-failure operation. In addition, the smaller sets incorporate equipment providing safety shut-down.

SLOTTED-ANGLE CONSTRUCTION

The Handy Angle Manufacturing Company, Limited, Grand Buildings, Trafalgar-square, London, W.C.2, are now making a slotted-angle system for construction work. An example is shown in the illustration. The angle is made from 14-s.w.g. cold-rolled steel, and has a single row of slots in each flange. The section is 1½ in. by 1½ in., and is normally supplied in 10-ft. lengths. The system includes triangular anchor plates, two of which may be seen in the illustration. The length and spacing of the slots is such as to allow connection to be located anywhere along the angle. Various sizes of shelf can also be obtained.

The fixing bolts are shallow domed and cannot rotate in the slots, enabling the nuts to be tightened by the use of one spanner only. A smooth exterior also results. The angle is rustproofed and can be finished satin bronze or lacquered. There is a wide range of accessories which can be used with it. The " standard packets " in which it is normally supplied, contain 100 ft. of angle, 100 nuts, bolts and washers, and 20 anchor plates.



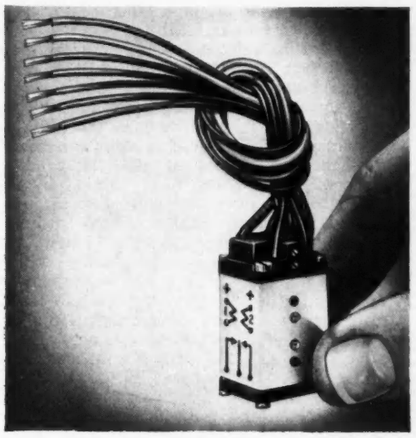
The bolts holding the angle to the anchor plates cannot rotate in the slots and so can be tightened by one spanner only.

MINIATURE MOVING-COIL RELAY

A miniature relay for instrument work or similar applications has been introduced by Electro-Methods Limited, Caxton-way, Stevenage, Hertfordshire. It is shown in the illustration below and measures 1⅜ in. by ¾ in. by ⅝ in. It will operate on a power input of 10 micro-watts.

The relay consists of a balanced moving coil mounted in the field of a permanent magnet. The coil has a contact leaf which can move between two adjustable contact springs mounted on the frame. The direction of movement depends on the direction of the operating current. The coil has two independent windings which can be wired singly, in series, in parallel or in differential, according to circuit requirements.

Since the coil is balanced, the relay can be mounted in any position; it is also magnetically self-shielded. The contacts are capable of handling non-inductive loads with values not exceeding 50 volts, 100 milliamperes or 2 watts, either alternating or direct current. Two models are made, one having coils of 100 ohm. resistance and the other of 350 ohms. Suggested uses are in bridge circuits with resistance thermometers, in self-balanced bridges in which they obviate the need of an additional amplifier, with light-sensitive cells or as instrument overloads.



With outside dimensions of 1⅜ in. by ¾ in. by ⅝ in., this relay has directional operation for an input of 10 micro-watts.

* * *

WATER REPELLANT

Protection of Brickwork and Plaster

A silicone product, giving a high degree of water repellency to exterior concrete, brickwork, stone, plaster, etc., above ground, is being marketed by Solignum, Limited, Donington House, Strand, London, W.C.2, under the name of Impervion (Silicone) water repeller. Rain and moisture run off the treated surfaces so preventing the entry of the water into the pores of the material, but surface " breathing " by the material still occurs.

The solution when dry is odourless, non-corrosive, non-inflammable and colourless. It should be applied liberally by brush or spray to dry surfaces which should afterwards be protected for at least six hours after application; a second coat after 12 hours may be required on coarse surfaces. Full repellancy is claimed after 24 hours, assisting in preserving the treated surface against the attacks of frost, chemical and other noxious vapours.

PRE-CAST CONCRETE SHELL-ROOFED WORKSHOP

DESIGNED ON A 24-FT. SQUARE MODULE

The use of a 24-ft. square module for design of the layout, the incorporation of a comprehensive system of service ducts in the main and secondary ground beams, and the employment of large pre-cast concrete members (including roof shells fabricated on the " in-line " principle at site) are three features of a workshop block now nearing completion for a new technical college at Kingston-upon-Hull. The building straddles one end of the site of the Old Queen's Dock, which was built in about 1780 and was filled in about 20 years ago to form Queen's Gardens; this dock, like others in the centre of the City, was originally constructed in what was the moat of the old City, and the subsoil above the underlying boulder clay, particularly the filling in the docks area, is poor. For this reason, the foundations have been piled.

The workshop block, a single-storey building with a shell roof, is 312 ft. long by 192 ft. wide and has been planned on a module or grid 24 ft. square. It is divided into four blocks by corridors, 12 ft. wide, running the width of the building. The frame consists of a series of north-light bays of pre-cast reinforced-concrete members, post-tensioned after erection by the Lee-McCall system; the shell roof is similarly composed of pre-cast units and each roof unit and north-light together span the 24 ft. of the grid. A shell unit being slung into position above the frame is shown in the accompanying illustration. The corridors have flat slab roofs, also pre-cast, resting on tubular rollers to allow for thermal movements of the building.

An entrance wing and temporary main corridor at present take the place of the entrance hall which will ultimately form part of the ground floor of a nine-storey main block.

DUAL-PURPOSE GROUND BEAMS

The suspended ground floor, of reinforced concrete placed *in situ*, contains a comprehensive system of main and subsidiary ducts throughout its area, to be used for as many services as may now, or at any future time, be concealed in this fashion. Both the main and subsidiary ducts are so arranged that they form the main beams of the floor construction; they also incorporate fixed-end sockets for the columns of the superstructure. Part of the building has a lowered floor to permit the introduction of machinery bases isolated against the transmission of vibration. These are for the heat engines laboratory. The floor of the hydraulics laboratory embodies a flume for experimental work.

CONTINUOUS-FRAME SUPERSTRUCTURE

The main frames have been built from the pre-cast units to form eight-bay continuous portal frames. Two basic units have been used: a combined column and north-light strut, and a curved rib. The units, cast with " Uni-Tube " ducts for the prestressing rods, were placed in position using a Scotch derrick, the high-tensile steel " Macalloy " bars threaded through the overlapping members, the joints concreted, and finally the bars stressed and grouted.

The gutter units, which provide the lateral bracing between the portal frames, were sufficiently prestressed to withstand handling stresses, but were later further post-tensioned when in position. This process of partial stressing, followed by completion of the prestressing as an integral part of the construction of the frame, is well suited to the Lee-McCall system of screwed bars with lock-nut anchors.

Each unit of the shell roof is 2½ in. thick, spans across 24 ft. and is 16 ft. wide, and weighs 7 tons. In view of their size they have been cast on the site, in batches of eight, in-line, on a prestressing bed laid down in a bay of the previously constructed ground floor. Eight gutter units were cast simultaneously with the eight roof shells. The shells were fixed in position by laying them on to the frames, bolting them down, and then filling between adjacent shells and above the supporting ribs of the frame with *in situ* concrete. Almost from the beginning of erection, the rate of progress has been eight bays of superstructure in every two weeks.

THE PRESTRESSING BED

The prestressing bed is over 200 ft. long and the 5-ton jacking head is about 20 ft. wide to embrace the 16-ft. combined width of a roof shell and one gutter unit; the bed is shown below where the relative positions of members when being stressed is clearly illustrated. The head could be used over its full width, and when all the wire had been stressed—the wires were stressed in pairs—a total compressive force of about 450 tons had been generated.

To reduce bending moments induced in the floor, rocker bearings have been provided at floor level ensuring that the stressing load is transmitted axially. A rolled steel joist cast into the floor acted as a spreader and was well anchored down to provide frictional resistance opposing any vertical movement of the plated channels to which the wires were attached for stressing. The forces exerted by the prestressing wires, which are about 15 in. above the floor, after the jack had been disconnected, were counter-balanced by " Macalloy " tie bars buried in drain pipes 5 ft. below the floor slab. The forces in the wires and in the counter-balancing tie rods are transmitted to each other by the plated channels already mentioned.

The wires were stressed in pairs by a travelling jack which has a compensating device in the gripping head. Correct location of the wires was ensured by the use of a jig-drilled R.S.J. former at each end of the stressing bed. To " de-tension," that is, put the load into the concrete, the loads in the tie bars were gradually slackened, the jacking head pivoting about the rocker bearings until all the load had been transferred from the anchorages to the concrete members.

The timber moulds rested on steel scaffold tubes bedded in mortar. This facilitated levelling and, moreover, allowed the moulds to slide freely during pre-tensioning. The ends of the moulds of the roof units were steel plates, jig-drilled for the 192 steel wires of 0·2 in. diameter used for each unit. The concrete mix was 1 : 1 : 2 and the water/cement ratio 0·34. Washed Trent river sand and gravel were used and, with rapid-hardening cement, a 5,000-lb. per square inch concrete was obtained in two days, when de-tensioning was put in hand. The concrete was placed by derrick using bottom-dumping skips, and was compacted with the aid of a pneumatically-vibrated travelling tamper shaped to the contour of the roof shells.

One of the two cranes used at the site was employed in moving the units and in serving the second crane erecting the superstructure. The shell units were lifted in a frame which consisted of two shaped channels, one at each end of the unit, welded tubes connecting the channels and a pyramid sling; this frame was fixed to bolts cast in the shell and later burnt off.

The general contractors for the new buildings have been William Moss and Sons, Limited, North Circular-road, Cricklewood, London, N.W.2; the consulting engineers, Messrs. Scott and Wilson, 47 Victoria-street, London, and Sir Cyril Kirkpatrick and Partners, Caxton-street, Westminster, London; the architect, Mr. F. Gibberd, C.B.E., 35 Gordon-square, London; the pre-cast frames were made by Trent Concrete, Limited, Colwick, Nottingham; the prestressing wires were supplied by Richard Johnson and Nephew, Limited, Forge-lane, Manchester, 11; and the prestressing bars by McCalls Macalloy, Limited, Templeborough, Sheffield.

The superstructure frame is built from two units: a combined column and north-light strut, and a curved rib. The gutter units provide the cross-bracing and the pre-cast roof shells are put in place as finished units.

The roofing shells, 24 ft. span by 16 ft. wide, were stressed eight at a time, in line, together with eight gutter units. " De-tensioning " was done two days after placing the concrete.

A TWO-SPEED EPICYCLIC CLUTCH

OBTAINING A RAPID TOOL APPROACH AND RETURN ON CRANK PRESSES

The rate at which metal being pressed will accept plastic deformation limits the speed of a power press during the actual drawing operation, but there is no such limitation when the tools are approaching the work, or when they are returning after the end of the drawing stroke has been reached. It is obviously desirable that the "non-working" part of the forward stroke and the complete return stroke should be as fast as possible, leaving only the actual drawing to be done at the reduced speed, and numerous methods have been devised for achieving the desired change of speed automatically. Among them may be mentioned modified-motion linkages, direct-current electric motors with electrical control gear, and electro-magnetic clutches. All have their disadvantages. To obviate the troubles inherent with the older methods of speed variation on crank presses the "Clearomatic" clutch has been designed. It is now in production by Vickers-Armstrongs Limited, Newcastle-on-Tyne, for fitting to the Clearing presses designed by the Clearing Machine Corporation of America, and manufactured in this country by the Newcastle firm. Distribution of the presses and clutches is handled by the Rockwell Machine Tool Company, Limited, Edgware Road, London, N.W.2.

The Clearomatic clutch, which is equally applicable to single-action, double-action or triple-action presses, consists essentially of two Clearing "Tornadyne" clutches connected mechanically by a planetary gear train. It can be used to provide a rapid approach and return, and to slow down automatically to the drawing speed at any desired point in the stroke. A sectioned view of the unit can be seen in Fig. 1.

COMPRESSED-AIR OPERATION

The clutch has three principal assemblies, a flywheel assembly, a planet pinion assembly, and a clutch spider assembly. These are shown diagrammatically in Figs. 2 to 4. The flywheel assembly has the sun pinion of the planetary gear as an integral part; this pinion therefore rotates at the same constant speed as the flywheel. The planet pinion assembly is keyed to the driving shaft of the press, and has five planet pinions running on anti-friction bearings mounted on heat-treated pins which are integral with the pinion hubs. The clutch spider assembly consists of the high-speed and low-speed spiders and the annulus gear, all of which are splined together as a single unit. The two clutches, which may be seen towards the top of the unit, are compressed-air operated, under the control of electrical limit switches operated by the press ram, and solenoid-type air valves. A standard Clearing Tornadyne spring-operated air-released brake, which is not shown in the illustration, is used to stop the press at the end of the return stroke.

TWO-SPEED OPERATION

In operation the high-speed clutch is energised by the entry of air behind the diaphragm in the flywheel. This causes the clutch spider assembly, which includes the internal planet gear, to rotate at the same speed as the flywheel, and in the same direction. Consequently, the press drive shaft also rotates at the same speed as the flywheel, and the tool approaches the work rapidly. The high-speed motion is shown diagrammatically in Fig. 2.

Just before the tool makes contact with the work a limit switch controlling a solenoid air valve operates and exhausts the air from behind the high-speed clutch diaphragm, thus disengaging the clutch. The low-speed clutch is then engaged, and this stops the rotation of the clutch spider assembly. As the sun pinion continues to rotate with the flywheel, the planet pinion assembly, and therefore the drive shaft, are caused to rotate at approximately one-third the speed of the flywheel, and in the same direction. The remaining portion of the press stroke is thus made at a reduced speed of approximately one-third of the approach speed. The drawing speed motion is indicated by Fig. 3.

At the bottom of the stroke the low-speed clutch is disengaged, and the high-speed clutch re-engaged for rapid return of the press to the top of the stroke. At this point the high-speed clutch is disengaged, and the press is stopped by the brake. Both clutches are now disengaged, and the planet pinion assembly is free to rotate in the idling position until the cycle is started again. Idling is shown in Fig. 4.

The limit switch controlling the clutch operation can be set to operate at any point in the stroke, and the speed can thus be changed at exactly the point required. For setting purposes the controls are so arranged that the "inching" push-button operates the low-speed clutch, and the press is therefore "inched" at the lowest speed. A selector switch is provided on the control panel to enable the press to be operated in any one of three different ways. For normal drawing it can be worked with the high-speed approach and return and low-speed draw; for drawing brass and other non-ferrous metals the press can be operated at high speed throughout the stroke; or if required it can be operated at low speed, and then becomes the equivalent of a conventional press.

The gears are of heat-treated alloy steel, cut to close tolerances and, since the sun pinion is smaller than the drive pinion on the end of the drive shaft, the peripheral velocity of the planet gears is lower than that of the main drive gear; the result is long life of the gears. The clutch linings are subject to a unit pressure of 25 to 30 lb. per square inch; this coupled with the large area of the facings, ensures that the clutches are cool-running, and have a long life. The clutch spiders are of light alloy, to reduce their kinetic energy, and further assist in cool operation. Clutch facings are interchangeable, and can be replaced quickly when necessary. All the bearings and gears are lubricated from the centralised lubrication system on the press.

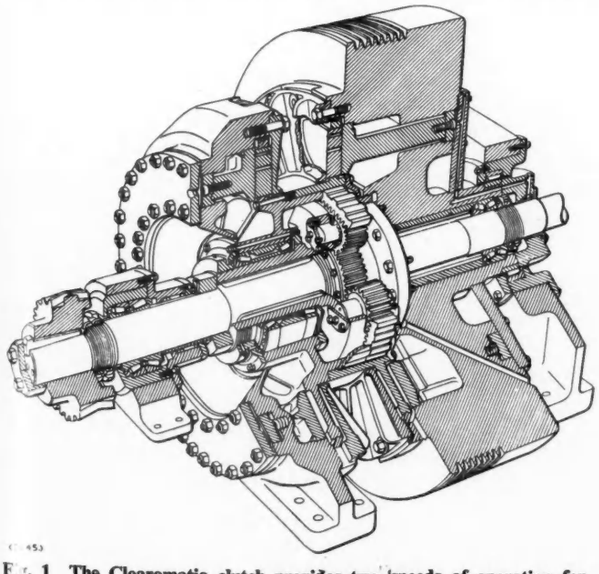


Fig. 1 The Clearomatic clutch provides two speeds of operation for a press: a high speed for approach and return, and a lower speed during the actual working part of the stroke.

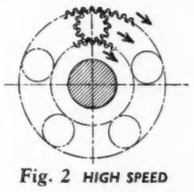


Fig. 2 HIGH SPEED

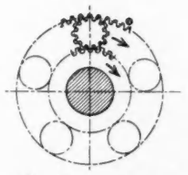


Fig. 3 LOW SPEED

Fig. 4 DRIVESHAFT STOPPED

"ENGINEERING"

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SCHOLARSHIPS IN NAVAL ARCHITECTURE AND MARINE ENGINEERING

The Institution of Naval Architects announce that two Denny scholarships, one in naval architecture and one in marine engineering, will be awarded during 1955, to students under 19 years of age. Each scholarship has an annual value of £175 and is tenable for four years at Glasgow University, with an apprenticeship of five years. Candidates must be British subjects who have not yet commenced their apprenticeships, or who have completed not more than one year of an apprenticeship to William Denny and Brothers, Limited, Dumbarton. In either case, they must previously have attended an approved public school or a school under an education authority. The closing date for entries is May 31.

The Institution, whose headquarters are at 10, Upper Belgrave-street, London, S.W.1, also announces that the Institution of Naval Architects, Elgar, and Martell scholarships have been amalgamated, in order that scholarships of higher value may be granted, and that the new awards will be known as "I.N.A.-Elgar-Martell Scholarships." These will have an annual value of £275 and will normally be open for competition in alternate years, commencing in 1955. The closing date for this year's entries however, was to-day, January 14.

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AWARD OF MOND NICKEL FELLOWSHIPS FOR 1954

Four Mond Nickel Fellowships have been awarded for 1954 by the Mond Nickel Fellowships Committee, 4, Grosvenor-gardens, London, S.W.1. The recipients are Mr. M. Brownlee, and Mr. F. B. Peacock, of Dorman, Long and Company, Limited, Middlesbrough; Mr. R. D. Butler, of Imperial Chemical Industries, Limited, Liverpool, and Mr. A. M. Sage, of the British Iron and Steel Research Association, London. Mr. Brownlee will study British, Continental and American hot and cold-metal basic open-hearth steelmaking practice, and Mr. Peacock, rolling-mill operation and maintenance. Mr. Butler will study mineral-dressing practice in this country on the Continent, in the United States and Canada, while Mr. Sage will study the manufacture and fabrication of structural steels in the United Kingdom, Europe, the United States and Canada.

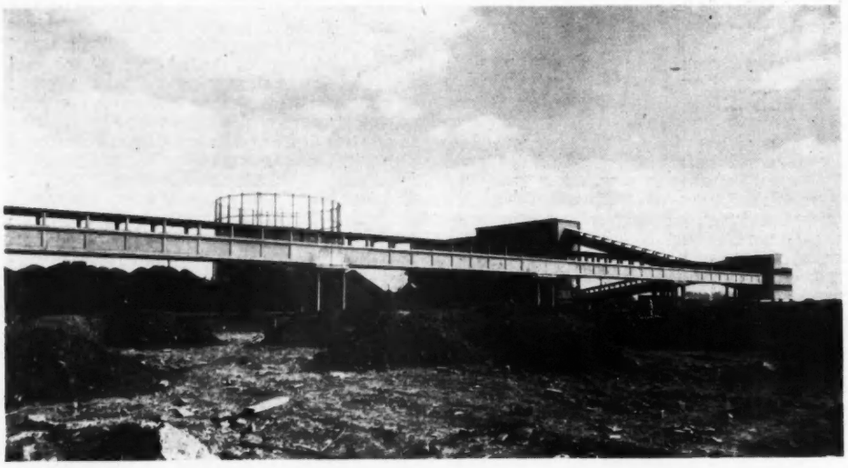

Fig. 1 The conveyor gantry leading from No. 2 coke plant. The gantries are of box section, simply-supported over 90-ft. spans; the two sides of the box have been designed as prestressed-concrete girders with ribs extended to support the roof.

CONVEYOR GANTRIES

PRESTRESSED-CONCRETE CONSTRUCTION AT A GASWORKS

Extensions which are now being made at Willoughby Lane Gas Works for the Eastern Gas Board, Tottenham Division, consist of an 8 million cub. ft. per day continuous vertical carbonising plant with all ancillary works, together with coal- and coke-handling machinery. The new plant is situated within the boundaries of the existing works, on a site immediately west of British Railway's London to Cambridge line. The coal- and coke-storage areas lie east of the railway. This divided layout necessitated an extensive conveyor belt system, and while the new work was being carried out the opportunity was taken to provide coal-handling facilities suitable for dealing with the present-day irregular supplies of coal and for efficient handling with the minimum of labour.

The conveyors take coal from the wagon tipplers to the carbonising plant and to and from the coal store, and also carry coke from the carbonising plant to the coke bunkers, which are equipped with grading apparatus.

Coal comes direct from the main goods line, either from north or south, into sidings which can take full trains of coal trucks. There are two wagon tipplers of the side-discharge type, each with automatic weighing machines, and their separate receiving hoppers feed two inclined belt conveyors each 48 in. wide. These conveyors carry the coal up to two elevated coal breakers which reduce it to 2 in. maximum size. From the base of the building housing the coal breakers, two 36-in. wide band conveyors, inclined at 18 deg., move the coal up again to three circular coal hoppers, each of 600 tons capacity.

At the hopper outlets, electric vibrating feeders pass the coal to shuttle belt conveyors which are so arranged that mixed coal of two or three grades can be fed at the rate of 100 tons per hour to either an intermittent carbonising plant which forms part of the original works or to the new plant. The 24-in. conveyors from the coal hoppers to the retort houses first pass in a gantry over the main railway lines to a tower housing a secondary coal crusher and then by inclined gantries to the distribution conveyors over the retort-bench coal bunkers. One gantry runs north to the new plant, the other south to the previously-existing plant.

After screening, coke produced in the old plant is used principally for the gas producers to each carbonising plant and for the manufacture of carburetted water gas. The quantity required for the new plant and for carburetted water gas is conveyed by way of the gantries in which coal is taken to the two plants. Coke from the new plant comes back in a separate gantry which passes the coal gantry on an opposite incline; then by duplicate conveyor it passes back over the railway in the gantry supporting the coal conveyors, and finally by a separate system, shown in Fig. 1, to the coke hoppers east of the railway. Most of the overhead conveyors are carried in prestressed-concrete gantries which have a total length of 2,927 ft. The transfer towers, coal hoppers and coke hoppers are of reinforced concrete.

In addition, there is a 24-in. conveyor 1,605 ft. long which runs the full length of a paved coal store and fed by a conveyor from the shuttle belts at the coal hopper outlets, and a reclaiming conveyor which also runs the length of the store and feeds coal back to the bunkers by way of the tippler hoppers.

PRESTRESSED GANTRIES

The gantries are designed as a box section 10 ft. 2 in. deep and varying in width from 5 ft. 8 in. to 11 ft. 6 in. The sides of the box are formed by two prestressed-concrete girders 6 ft. 6 in. deep, the ribs of which continue upwards to form the upper frame; the base is a reinforced-concrete slab. The minimum thickness of the girder web is 7 in. and the thickness at the ends is 12 in. Concrete purlins fixed to the frame members carry a roof covering of curved asbestos-cement sheeting. The section of a gantry is shown in Fig. 2, and the interior after the installation of the conveyor belts in Fig. 3, opposite.

All the gantries, with the exception of that over the railway, are made up of simply-supported spans, in most cases 90 ft. long, designed in accordance with the method derived by Professor G. Magnel. The gantry over the railway is continuous over two spans of 108 ft. and 78 ft. and was designed according to the methods of Monsieur Y. Guyon.

The gantries are supported by transfer towers at the ends of conveyors and intermediately on trestles, double trestles being provided to allow for stressing jacks. All the spans have fixed supports at one end and sliding bearings at the other with a gap of approximately 1 in. to allow for shrinkage and thermal expansion.

The girders were prestressed on the Magnel-Blaton system. Three cables, each made up of 24 wires of 0·276-in. diameter, were used for spans up to 90 ft., and four cables for the maximum span of 108 ft. They are curved to a minimum radius of about 370 ft., except for the continuous bridge over the railway, where the cable radius over the intermediate support was 100 ft. The steel used in the first part of the work had an ultimate strength of 90 to 100 tons per square inch and was stressed to 54 tons per square inch. For the major part of the work however, steel wires with an ultimate strength of 95 to 105 tons per square inch have been used, and these have been stressed to 57 tons per square inch.

The design required that the stresses in the concrete at the time of prestressing should not exceed 2,500 lb. per square inch and that there should be no tension stresses. At full working load, with allowance for creep and shrinkage, the compressive stress in the concrete was not to exceed 2,000 lb. per square inch. At least 100 lb. per square inch was also required as residual compression in all sections as a safety margin against tension cracks. For the 90-ft. span the actual maximum compression in the bottom flange at the time of stressing was 1,403 lb. per square inch and under working load compression in the top flange is 1,274 lb. per square inch. The two-span continuous gantry over the railway had a maximum compression stress of 1,790 lb. per square inch at the time of prestressing and 1,880 lb. per square inch under working load.

Cable ducts were made by rubber cores, $2\frac{1}{2}$ in. by $3\frac{1}{2}$ in., stiffened by a $\frac{3}{4}$-in. diameter steel rod. The cores were held in position by $\frac{1}{2}$-in. diameter mild-steel stirrups and supported in the correct horizontal position and to the required curvature by steel pins passed through the formwork.

The simply-supported girders were stressed by means of a hydraulic jack at one end only, but a jack at each end was used for stressing the two-span continuous gantry. In all cases the extension of the wires was checked to ensure that the proof stress was not being exceeded. After stressing, the cable ducts were grouted with 1 part of cement to $1\frac{1}{2}$ parts of sand applied under a pressure of 25 lb. per square inch.

The mix used for the concrete was 1 cwt. of cement, 170 lb. sand, 290 lb. of $\frac{1}{4}$-in. to $\frac{5}{16}$-in. shingle and not more than 55 lb. of water, giving a uniform $\frac{1}{4}$-in. slump. This met the specification requirements of a minimum crushing strength of 6,000 lb. per square inch after 28 days. The concrete was weighbatched and compacted by internal vibration.

Test cubes were made of the concrete used

Fig. 2 Incomplete section of a gantry showing the framing and prestressing anchors.

Fig. 3 Interior of one of the gantries.

for each gantry and the cubes cured under the same atmospheric conditions as on the job. The cubes had a compressive strength of 6,000 to 8,000 lb. per square inch after 14 days and between 7,000 and 9,000 lb. per square inch after 28 days, except for some cubes cast during cold weather, when the temperature was between 33 deg. and 40 deg. F. for approximately a fortnight. These cubes gave 5,300 lb. per square inch after 14 days and 7,700 after 28 days.

AIR-ENTRAINED CONCRETE

In addition to the coal hoppers and gantry transfer towers other construction has been carried out in reinforced concrete, including a set of 36 elevated purifier boxes each 30 ft. square and 7 ft. 6 in. deep, coke hoppers, paved storage areas for coal and coke, framing for a power house and various foundations for plant.

The purifier boxes were designed in accordance with the Code of Practice for the storage of liquids, and a high-grade concrete of 1 : 1½ : 3 mix was used. For all the other reinforced-concrete construction a 1 : 2 : 4 mix was used, weighbatched.

For most of the construction air-entrained concrete was used. Tests were carried out using air-entrained concrete and normal concrete made with similar materials and under similar conditions when a paved coke yard was under construction. In each case the concrete was weighbatched with the minimum water for correct compaction without vibration. With the addition of the air-entraining agent less water was required for a particular slump, with the result that the air-entrained concrete gave a much higher test strength. The figures and data relating to this test are as follow.—

	Air-entrained concrete	Normal concrete
Volume of slab, cub. yd.	34·5	34·5
Weight per mix, lb.:		
Cement	112	112
Sand	250	275
Gravel	500	500
Number of mixings in slab	154	152
Total weight of materials in slab, lb.	132,748	134,824
Weight of concrete, lb. per cub. ft.	142·2	144·7
Weight of materials, lb. per cub. yd. of concrete:		
Cement	499·8	493·4
Sand	1,116	1,214
Gravel	2,232	2,203
Test cubes, 6-in. cubes:		
Average density, lb. per cub. ft.	144·8	146·2
Crushing strength after 28 days, lb. per sq. in.	6,600	4,668

The contractors and associated designers for the prestressed and reinforced-concrete work have been Peter Lind and Company, Limited, Stratton House, Piccadilly, London, W.1; the mechanical contractors, Hugh Wood and Company, Limited, Gateshead, 11. The responsible divisional engineer was Mr. E. O. Rose, M.I.C.E., and the constructional engineer, Mr. W. T. Gedge, M.Inst.GasE.

INDUSTRIAL ATOMIC ENERGY

Techniques and Application

One of the advantages to be derived from atomic energy is that the plant need not be shut down for refuelling, but can continue in operation for a very long time without a break, the time probably depending on the associated equipment rather than the fuel supply. The possibilities of this have led to many prophecies, many of which seem likely to be fulfilled: of ships remaining at sea for years at a time without refuelling, for example.

It is, of course, necessary that no part of the plant should break down if this continuous operation is to be achieved, and particularly is this the case in the reactor itself where radioactivity renders maintenance almost impossible. At the Windscale plant, an illustration of which taken at night is given, the pipework in the reactor zone, which was installed by Ashmore, Benson, Pease and Company, Limited, Stockton-on-Tees, is of stainless steel welded by the Argon-arc system to a standard above that required by Lloyd's Class I grading. No flanged joints were allowed and every weld was examined throughout the set-up, some by X-rays and some by iridium 192. Much of the welding had to be done on site, and a special training school was set up.

RAPID DEVELOPMENTS

In a field in which as much time and energy are being expended as in the development of nuclear energy for peaceful and industrial uses, it is very difficult to keep abreast of the latest happenings, but at least the offers of fissionable material that have been made by both the United States and the United Kingdom do form a landmark. That these offers are timely and acceptable is borne out by the reports of developments proposed in other countries. France, for one, has gone so far as to appoint a Secretary of State for Scientific Research and Technical Progress followed by a complete re-organisation and co-ordination of the governmental research institutes. Plans for future development include six accelerators, two synchro-cyclotrons and a betatron, some of which will be of wholly French design and construction.

Moreover, the United States' plans for allowing private (as distinct from government controlled) research to be carried out will undoubtedly act as a great spur to development, for American competition is proverbial. In this connection, also, may be included the announcement by the Battelle Institute, the headquarters of which are in Columbus, Ohio, U.S.A., that they are carrying out a large expansion of their nuclear-energy research facilities. This will include the construction of a nuclear reactor, a development laboratory and of a nuclear-fuels laboratory, together with the installation of a large cobalt-60 source, all of which will be available for contract work for private firms. The reactor will be of the " swimming pool " type, that is one in which the core is submerged in water which acts as moderator, coolant and shield. In Britain, three-month courses are being run at Harwell on the methods of using heat from reactors.

Russia claims to be leading in the production of electricity from nuclear energy, for the late Mr. Vyshinsky announced in November that their first power station had commenced operation on July 27, 1954. In Britain, a power station is being built at Calder Hall, Cumberland, which will enable experience to be gained in the operation of such plants. It is expected to be completed next year, 1956, and it will have a capacity of 50 MW. In the United States, a contract for a similar plant was announced last October; construction is expected to begin this year and the station should be completed in 1956. Other developments in America using nuclear energy as their fuel supply are the submarine Nautilus, which is now in service and details of which have been described, and the recently launched carrier Forrestal. For the Merchant Navy, a model has been constructed of a 560-ft. Mariner class vessel with a nuclear reactor taking no more room than the standard boiler room. The cargo space is, however, increased as no fuel tanks are required. Designs have also been laid out for an atomic locomotive, but the necessary size would appear to militate against this.

At Windscale atomic energy station the primary separation plant is complete; in the foreground are the solvent-recovery plant and the workshops.

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WELDING ANTI-SPATTER PAINT

A paint for application to surfaces to be welded to prevent spatter and slag particles from sticking to the work has been placed on the market by the Arc Manufacturing Company, Limited, Actarc Works, Nitshill, Glasgow. The paint, which is stated to be non-toxic, non-corrosive, non-fuming and non-irritant, is a flux in itself and also assists ionisation and stabilises the arc. The paint is called " Kleenarc " and is supplied in powder form; it is mixed with water or methylated spirit to a creamy consistency and applied to the surface of the work with a small paint brush. It is pointed out that the paint is particularly useful for protecting bronze, stainless steel and other machined steel surfaces and also welding jigs from spatter accumulations. After the welding operation the paint is quickly removed from the work by an ordinary wire brush.

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ZINC-ALLOY DIE CASTING

European Bulletin

The first issue of a new series of European bulletins on zinc-alloy die casting has recently been issued. The publication is the result of close collaboration between the Zinc Development Association, Lincoln House, Turl-street, Oxford, the Commission Technique des Alliages de Zinc, 76 Rue de la Victoire, Paris 9; the Zinkberatung, 44 Schützenstrasse, Düsseldorf, and S.A. Montevecchio, 18 Via F. Turati, Milan. These authorities will prepare successive identical issues in English, French, German and Italian, respectively, and copies of the edition in English may be obtained, gratis, on application to the Zinc Development Association. The present first issue of the bulletin is devoted to the use of zinc-alloy die castings in the European motor-car industry. Subsequent numbers will deal with other fields in which the castings are used.

MIXED THERMAL-HYDRO-ELECTRIC SYSTEMS*

TECHNICAL AND ECONOMIC PROBLEMS IN DESIGN

By T. G. N. Haldane, M.A., *and P. L. Blackstone*, M.A.†

The capital cost of hydro-electric power is made up of expenditure on the main storage works and associated aqueducts, and on the tunnels, pipes, buildings, plant and transmission. The storage works are not directly dependent upon the installed capacity, but the tunnels and pipes are designed to pass the required full load flow and their cost is thus directly connected with that capacity. The capital costs therefore consist of a fixed amount, representing storage, and an amount which varies with the installed capacity. It will be found that for most projects the incremental cost of increasing the plant, together with the provision of larger conduits and transmission lines is less than the capital cost of adding to the installed capacity of a thermal station.

In countries where hydro-electric resources predominate and where fuel is costly, it is probable that a comparison of generation costs will favour a hydro-electric project over a wide range of installed capacity. Some thermal plant is, however, nearly always essential for the full exploitation of hydro-electric resources, even in countries particularly well endowed with water power. In fact, with the continued growth of load a larger proportion of the plant will be necessarily thermal. In a predominantly thermal system it will usually be preferable to develop such water power as can economically be justified. In such a case the spilling of water at times of high run-off can be reduced, with the result that the available water is better utilised and the fuel used by the thermal plant decreased.

OPERATION OF A PURELY THERMAL SYSTEM

In a purely thermal system the machines will, as far as possible, be brought into operation in ascending order of fuel cost per kilowatt-hour, so that the least efficient machines run on peak load only. So long as the increase of efficiency of thermal plant continues this will result in a maximum reduction in the average fuel consumption for the system. In practice, however, reduced availability of base-load plant and lack of flexibility of peak-load plant results in the less efficient stations generating more than their theoretically desirable quota, and the more efficient stations generating less.

Hydro-electric plant has a higher availability than thermal plant and is more flexible because it can be started, synchronised and brought up to full load more quickly. It is therefore especially suited to rapid load fluctuations and its use in this way benefits the operation of the system as a whole. The assumed hydro-electric output must, however, be "firm," otherwise it might be necessary for the thermal plant to be brought in to cover water deficiency. In wet weather the water power can be utilised at a load factor higher than that intended, thus saving fuel. Consequently, in a combined system temporary departures from design operation will be desirable and will result in overall economy, whereas any departures in the all-thermal case produce an overall loss.

OVERALL FUEL CONSUMPTION

The introduction of hydro-electric plant at the top of the load duration curve results in a saving of the fuel which would have been needed to generate the actual hydro-electric output and of the fuel required to keep the equivalent thermal plant available for peak load operation. The quality of operation in the peak region is improved, because the hydro-electric plant is capable of of following more closely the momentary variations in demand. On the other hand, there is a temporary loss of the chance to improve the average thermal efficiency, which results from the addition of new plant. The first two of these factors can be fairly closely calculated and the third can be estimated. To assess the fourth is more complex and may not be feasible except as a rough approximation. It should, however, be possible to reach a reliable conclusion as to the existence of an operating economy or loss, if not its magnitude.

The annual load factor of a thermal plant can be varied as desired within certain limits, but that of a hydro-electric installation must be determined before the scheme is designed. It would therefore be wise to look well ahead at the planning stage and consider the provision that should be made for an increase in capacity. For instance, the Tennessee Valley Authority have almost reached the limit of their potential economic water-power resources, and so as to meet new demands are now constructing base-load thermal plants and have installed extra machines in spare bays in many of the existing hydro-electric stations.

STORAGE PROBLEMS

The proportion of the total mean annual output of hydro-electric plant which can be guaranteed in the driest year is dependent on the amount of storage. Above about 80 per cent. of this output, however, the amount of storage required rises very rapidly and for any particular reservoir there will be some output which it is not economic to exceed by increasing the size of the dam. This may mean that a certain acceptable load factor can be guaranteed throughout part of the year, but not all the time. The doubtful period must be eliminated by reducing installed capacity or by installing thermal plant or pumps. The use of thermal plant for this purpose is expensive, but may be justified.

Essential requirements for the use of storage pumps are a tail race pond from which to draw supplies; and a source of off-peak energy for pumping. An energy loss of some 33 per cent. will be incurred, but pumping may be infrequent and the total amount of energy involved comparatively small. Moreover, the cost per unit for pumping supplied at off-peak hours will be less than the value per unit of the stored energy, if resold in peak hours. An advantage of the use of storage pumps is that the level in the reservoir can be maintained higher during periods of low run-off than it would otherwise be the case and the falling off due to decreased head can be reduced. In addition, the flexibility of reservoir operation is enhanced. The authors regard this use of pumps as an important development and think that in the planning of any storage project where there is a tail pond the possibility of using them should always be considered.

Pure pumped-storage can be regarded as the ultimate development of pumping. The pumped-storage plant and a natural low load factor development are similar in their effect on the overall fuel consumption of the system, except that the former is handicapped by the cost of the pumping energy. After the introduction of the storage plant the overall fuel consumption will temporarily be increased, but this increase will diminish owing to the effect of the retarded improvement of thermal-plant efficiency lessening as the load factor of the "displaced" thermal plant decreases. Over a long period there is possibly a very small saving in fuel by using a storage plant. If therefore the capital cost of pumped storage plant is less than the cost of a new thermal plant the former is almost certain to give an overall advantage. Considerable flexibility is possible in planning a storage scheme, but the pump capacity, pumping period and reservoir capacity must be considered if the most economical scheme is to be achieved.

EFFECT OF NUCLEAR POWER

As large hydro-electric projects have to be planned many years ahead and have an assumed life for amortisation purposes of more than half a century, it is necessary to consider the probable effect upon them of nuclear power stations. These stations are likely to be placed in remote districts and will therefore require long distance transmission. They will involve relatively high capital and relatively low running costs. For economical reasons it will probably be desirable to keep their loading comparatively constant, so that they will not be so flexible in operation as hydro-electric stations. They are therefore likely to be operated on base loads and will become less economic when all that load has been supplied and further development might have to be at lower load factors.

The immediate question, however, is whether the prospects of cheap nuclear energy might make it advisable to postpone hydro-electric development and build shorter-life thermal stations instead. Such a policy would, however, seem to be imprudent. Even on the most optimistic assumptions it is likely to be at least a decade before the costs of nuclear energy fall below those of coal-fired energy and it may be still longer before nuclear stations compete with hydro-electric stations. There is also the ever increasing necessity to husband coal resources. The prospects of base-load nuclear energy, cheap in running cost, does, however, tend to strengthen the arguments in favour of the relatively low-load-factor development of hydro-electric stations.

HYDRO-ELECTRIC PLANT TECHNOLOGY

There has been no significant change in the fundamental design of hydraulic turbines for general power development since the introduction of the movable-blade Kaplan machine more than 30 years ago. Development has been concentrated on the improvement of efficiency, greater output, higher specific head and upper limit of head for each type. The present limits of efficiency are about 93 per cent. for Kaplan, 92 per cent. for Francis and between 90 and 91 per cent. for Pelton turbines. Outputs have been gradually stepped up to 165,000 brake horse-power for Francis machines at the Grand Coulee power station and 110,000 brake horse-power for Kaplans at the McNary dam. A contract for 175,000 h.p. Francis turbines of British design has recently been placed by the Quebec Hydro-Electric Commission for their Bersimis station. Single jet twin-runner Pelton turbines of 150,000 brake horse-power are now being constructed for the Cimego power station in the Italian Alps and four-jet single runner vertical impulse machines of about the same output are being installed in the Kemano station in British Columbia. The continuance of this upward trend in capacity is a matter more of economics than a technical problem.

The desire to reduce cost has led to higher speeds being adopted for a given combination of head and output. This has resulted in the upper limits of head for Kaplan and Francis turbines being continually increased, so that the higher specific speed Kaplan turbine is used up to heads which hitherto have been considered practicable only for the Francis type. Similarly, the Francis turbine is encroaching into the high head range of the Pelton. The highest head for which Kaplan and Francis turbines have yet been constructed are respectively 230 ft. at the Bort-Rhue plant in France and 1,490 ft. at Fionnay in Switzerland. The highest existing

* Paper entitled "Problems of Hydro-Electric Design in Mixed Thermal-Hydro-Electric Systems," read before a Joint Meeting of the Institutions of Civil and Electrical Engineers on Thursday, January 6, 1955. Abridged.

† Mr. Haldane and Mr. Blackstone are with Merz and McLellan.

head at present used for a Pelton is 5,800 ft., at Reisseck in Austria.

IMPROVED MATERIALS

These advances have been made possible by the use of materials which have a better resistance to cavitation and corrosion, and as the result of research into cavitation and runner blade profiles. It is important to realise, however, that the highest speed will not necessarily give the lowest overall installation cost. An increase of specific speed, particularly in the case of Kaplan turbines, is usually accompanied by a lower maximum efficiency and the greater depth of excavation necessary for the draught tube. In recent years there has been a greatly increased use of steel plate and fabricated construction and welding has almost completely superseded riveting. A fabricated Francis runner, however, is not necessarily cheaper than one of cast steel. This depends on the ability of the steel founder to produce a sound and accurate casting, which requires the minimum of cutting, welding and grinding.

Extensive interconnection has changed the function of the turbine governor from that of pure speed control to that of a frequency/power regulator. It must often be capable of control by any of several quantities, such as by frequency and output, water level and water or power flow; and it must be possible to combine these quantities and vary their relative magnitudes. In this respect the new electronic governor, which has been developed in Sweden, shows considerable promise.

The common methods of measurement of water flow to establish turbine efficiency have an inherent inaccuracy; and an appreciable tolerance, usually 2 per cent., is normally required by the manufacturer. To overcome the difficulties and cost of measurement on site there has been an increasing use of reduced-scale models tested under laboratory conditions. Whether or not this method gives the true prototype efficiency over the whole range of tests, it does produce results which from the contractual point of view cannot reasonably be disputed and no tolerance need be granted.

GENERATOR DESIGN

The tendency for turbine outputs and speeds to increase naturally reflects on the generator. When the rotor peripheral speed at normal running is below 15,000 ft. per minute the problem is principally one of transport and erection. With high-speed generators the problem is more that of the mechanical design of the rotor poles and coils to withstand the centrifugal stresses due to increased runaway speeds. The demand for an increased rate of exciter response and restriction of voltage rise on load rejection is leading to the replacement of the rheostatic-excitation control system by one of the electronic type.

It is likely there will be an appreciable demand for a reversible pump-turbine, the runner of which would not be a compromise between that which was best for the pump and that which was best for the turbine. An alternative would be an electrical machine with a low speed for generation and a higher speed for pumping. For low heads a further alternative would be a Kaplan-type runner with blades which could be reversed for pumping without changing the direction of rotation.

Opinions vary on the relative merits of fully manual, semi-automatic and fully-automatic control of hydro-electric plant. It is probable that large base-load plants will continue to be staffed and be either manually or semi-automatically controlled, but it seems likely that the use of fully automatic remote control for smaller peak-load plants will be extended, especially when they are situated in lonely and intractable country.

TRANSMISSION CONSIDERATIONS

From the aspect of deciding how a given water-power scheme should be developed or whether it should be postponed in favour of some alternative, the costs of the scheme itself and the necessary transmission are inseparable. A number of methods of increasing the load capacity of long lines by compensating the line reactance and capacitance and by maintaining the transient stability are in use, the collective effect being that there has been no great urgency to develop direct-current transmission. It seems likely that such transmission will in the first instance be employed for submarine and underground routes where its advantages are so outstanding.

The interconnection of the systems of two or more adjacent countries, thus reducing the required amount of plant, is likely to be particularly advantageous if one has predominantly thermal and the other hydro-electric generation. Even if both have predominantly hydro-electric generation there may be important diversities. It is usually impossible for one sovereign state to be dependent on another for electricity. Partial integration by means of high-voltage interconnection can nevertheless be of great advantage in saving plant, although the consequent reduction must not be so great as to leave either country seriously embarrassed if the interconnection is severed.

The authors conclude that the technical development of hydro-electric plant has reached a stage where there is limited scope for further improvement in design and efficiency. Since the cost of the civil engineering works predominates in most hydro-electric installations, it is mainly in this field that reductions can be looked for. In future, such savings as may be achieved may, however, be offset by the need to develop power at increasingly less favourable sites. On the other hand, a continuation of the steady improvement in thermal-plant efficiency is likely for some years to come. This may, however, be more than counterbalanced by further increases in the cost of fuel. The cost of thermal power can, however, be closely estimated at the time the plant is built although it is liable to unpredictable future variation. The cost of water power, while more difficult to assess in the first instance, remains virtually constant once the plant has been constructed.

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REINFORCING PLASTICS WITH GLASS FIBRE

Glass fibres were produced on a commercial scale thirty years ago, but it was not until suitable resins were developed during the last war that glass fibres could be used as a reinforcement for plastics. There are many advantages in using glass fibres as reinforcement; they have high tensile strength, good electrical properties, are relatively chemically resistant and have low heat conductivity. The resins which were obtainable before the last was as binders for the glass fibres evolved water vapour in curing; to drive off the water vapour high pressures were needed, and the glass fibres were damaged by the high pressure. Polyester resins were developed during the war in America, and they can be cured at pressures which do not affect the glass fibres. The resulting material, glass-reinforced plastic, has had many applications since it was first manufactured. Its possibilities for the future were discussed recently by Mr. A. Hudson Davies, managing director of Fibreglass, Limited, Ravenhead, St. Helens, Lancashire.

Glass-reinforced plastics have advantages and disadvantages which determine the way in which they are used. To summarise them briefly, the advantages are: low-pressure plastics can be moulded cheaply; low specific gravities allow greater skin thicknesses (compared with metal) without increasing the weight too much; materials are resistant to corrosion; variable thicknesses and local reinforcements are easy to produce; the materials have high impact strength, which is particularly important in the manufacture of car bodies. The main disadvantages of glass-reinforced plastics are: high cost (but the cost has been substantially reduced over the last three or four years, and it is hoped that there will be further gradual reductions); the materials are best suited to diffuse loadings, and stress concentrations are to be avoided; temperature resistance of plastics based on polyester resins is low; the materials are not fire-proof, though they can be made self-extinguishing by incorporating certain filters; they are less of a risk than hardwood, however, and the glass reinforcement acts as a flame barrier.

There are many applications for which Fibreglass reinforced plastics have been used. There is now a regular production of boats with plastic hulls up to 25 ft. in length, and special hulls are being made up to 50 ft. Plastic bodies for sports cars have been made in America for the last year or two, but the first production saloon car in the world with Fibreglass reinforced plastics body, the Jensen 541, was made in Britain and was exhibited at the Motor Show of 1954. Bodies for Jensen cars had previously been panel-beaten, and a very large proportion of the cost was taken up by the labour needed in panel beating; although the glass-reinforced plastics are more expensive than the metal previously used, the very low labour costs in moulding more than balance the increased charges for material. Fibreglass reinforced plastic is also used for corner panels for buses, where its high impact strength is of value.

In the making of large structures, such as a 45-ft. boat hull or a car body, the practice has been to use a male mould on which glass-fibre reinforcement is laid and then impregnated. These methods are easy to carry out and the cost of tooling is low, but for large-scale production they are too slow. In the U.S.A. a Chevrolet glass-fibre car body is planned, in the production of which a large number of matched metal moulds will be used. In these, glass-fibre mat impregnated with resin will be moulded at pressures up to 150 lb. per square inch, and will be cured by heating the moulds to a temperature of about 140 deg. C. In this way complete mouldings can be made in three or four minutes, but a much higher tooling cost is involved.

Mr. Davies said that a great future lies ahead of these materials, but it should not be thought that development will be easy or quick. Before any article can be said to be satisfactory it must have been proved in service; so far there has not been sufficient time for conclusive proof, although most products have stood up well to their working conditions. The properties of glass-reinforced plastics are not known in enough detail for engineers to use them as they use traditional materials. In time the details will be collected, but until then every new application must be approached with cautious enthusiasm. There is no lack of the raw materials, either the glass fibres or the resins, to prevent the expansion of this industry.

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STEEL FOR SHIPS

A short film has been made for the British Iron and Steel Federation on the steel used in shipbuilding. The film, entitled "The Sea Shall Test Her," was made by British Films Limited for B.I.S.F., directed by Jack Howells and produced by William Weedon. It is a film for a general rather than a specialist audience. The greater part of the film shows the steel-making process, and was taken in a number of big steelworks in this country. It gives a realistic picture of the conditions under which steel is made and the accuracy with which different ingredients must be added to make special steels. Further shots show the working of the steel into the forms necessary for various parts of the ship, and the construction work in shipbuilders' yards. The film runs for about 15 minutes, and is available from Sound Services, Limited, 269 Kingston-road, Merton Park, London, S.W.19.

SAFETY IN MINES

Report for 1953

It is stated in the report of the Safety in Mines Research Establishment for the year 1953 (H.M. Stationery Office, 3*s.* net) that " there is nothing inevitable about coal-dust explosions and that the degree of danger is largely bound up with the method of transport." The latter part of this remark refers to the relative difficulty of the problem of maintaining an adequate stone-dust content in the mixture lying in a mine road served by rope haulage or by locomotives and that of doing the same thing on a belt-conveyor road. Stone dusting has been practised for very many years and as the report points out, and as is well known, a mine roadway is safe from the risk of a dust explosion if the coal dust necessarily present is mixed with a sufficient quantity of stone dust. The maintenance of this sufficient quantity is the important matter and it is recommended that white-painted sampling trays should be placed at selected points. Regular inspection of their contents will indicate the rate of deposition. It is suggested that in some positions the accumulation of coal dust may not give rise to danger in a period of twelve months; in others, that condition may arise in a single shift.

On conveyor roads, and particularly near transfer and loading points, the rate of deposition of coal dust may be so high that conventional stone-dusting methods are ineffective. Coal dust that collects on the conveyor structure and below the belt is not air-carried and would not be deposited in sampling trays even if they were used. In connection with such dust accumulations associated with conveyors, the report states that " the only remedy . . . lies in better engineering, both in design and practice." In spite of this remark, a vacuum-cleaning equipment, described in another part of the report, would appear to offer possibilities of application to difficult situations. The prototype equipment is mobile and has been used to clear spillages, but no claim is made that it has yet been perfected. In particular, difficulty may arise owing to the formation of an explosive atmosphere in the collecting chamber and an explosion might be caused if the machine picked up smouldering coal. However, the general impression given by the report is that the vacuum-cleaning process is promising.

Experiments were carried out on the problem of frictional sparking associated with the use of alloys of magnesium and aluminium in an explosive atmosphere. This matter is of interest in many branches of industry as well as in coal mining. In the experiments described, a glancing blow was given on an inclined steel plate by a falling disc of the light metal. Over a range of aluminium-based alloys, it was found that there was roughly a linear relationship between the energy required to cause ignition and the magnesium content of the alloy. An alloy containing magnesium only as an impurity required only twice the energy needed with an alloy containing 10 per cent. of magnesium. Provisional evidence suggests that rust, or a smear of aluminium on the steel plate adds greatly to the ignition risk. There is some reason to think that if the aluminium in an aluminium-based alloy is replaced by zinc, the risk of ignition may be reduced. This matter is probably of particular interest in connection with mine props and roof bars, the latter frequently being of aluminium. It is reported that yielding props of various types were studied during the year. A new British hydraulic prop performed better than the friction-type props of German origin.

The report contains a section dealing with various mechanical failures and tests. Much use has been made of magnetic crack detection. In all, 1,308 components were examined during the year and 155 were found to be cracked. A fluorescent magnetic ink is referred to in very favourable terms. It consists of magnetic particles suspended in a light oil containing a fluorescent compound. A total of 566 welds in wrought-iron chain were examined by gamma radiography and 322 were found seriously defective. The method of repairing worn bearing surfaces of cage-suspension shackles by depositing a layer of metal by oxy-acetylene or metallic arc welding is condemned. No complete breakage of a colliery winding rope was notified during the year, but there was a case of such breakage in a metalliferous mine. The rope was ¾ in. in diameter and the drum 15 in., giving a ratio of drum diameter to rope diameter of 20; the normal figure for good winding practice is 100. There were six cases of breakage of man-riding haulage ropes, due to concentrated wear caused by kinks, localised corrosion, damage caused during a derailment and other conditions which better inspection might have revealed.

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LARGE-CAPACITY PALLET TRUCK

Hand Operated

For use where a power-operated pallet truck is not economical or convenient, a new hand pallet truck, the H.P. 50, has been introduced by Lansing Bagnall, Limited, Basingstoke, Hampshire.

The all-steel welded frame of the new truck, which is shown in the accompanying illustration, is built of box section girders which result in a capacity of 4,500 lb. with a service weight of only 3 cwt. (The Lansing Bagnall power pallet truck weighs 1,600 lb.). Normally this large capacity will not be fully utilised, as it would require the services of perhaps two operators to move a full load. In some departments, however, such as in maintenance and millwright shops, it is extremely useful to have a truck to hand which can carry such loads.

At other times, the truck can be put to good use in machine shops with narrow gangways, and in lifts. It can also relieve fork trucks of many transportation duties over short distances, so allowing these more expensive vehicles to be used exclusively where their power and their high stacking and loading characteristics can be fully employed.

The new truck can be supplied with standard fork lengths from 36 to 72 in. and with overall fork widths of 22 or 27 in.

The hydraulic pump for raising the load off the ground is operated by the handle, and the connecting leverage system is arranged to give the maximum effect towards the top position of the handle, so that heavy loads can be lifted easily even in the most cramped surroundings.

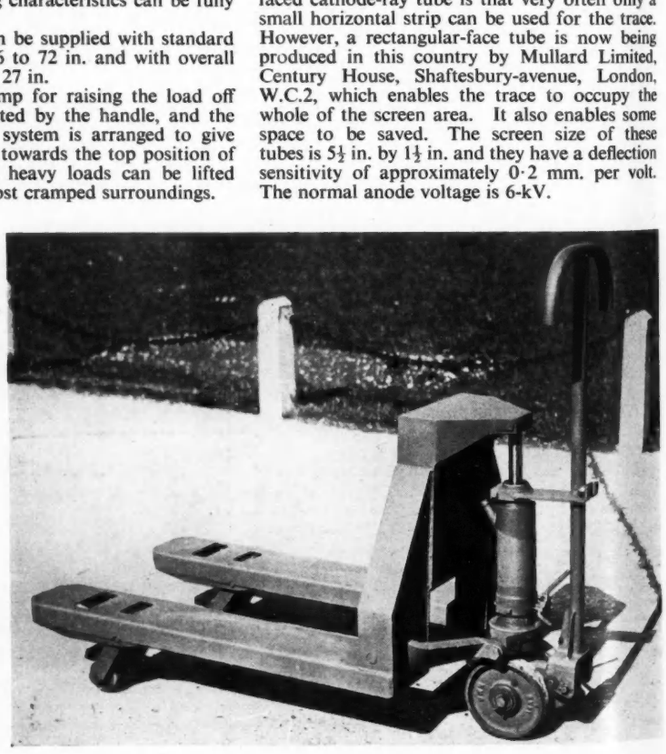
Where there is plenty of space and the load is relatively light, the full stroke can be used to give the full lift of 6 in. with the minimum of strokes. This high lift ensures ample ground clearance for wide pallets which are apt to sag. It also provides adequate ground clearance when negotiating ramps and other sloping surfaces.

The jack is specially designed to raise the load truly vertically, It is located inside the tank containing the hydraulic oil so that, in the event of any small leakage, the oil goes straight back into the tank. The bearings of the steering gear are also continually lubricated by the hydraulic fluid, since they are housed inside the tank, out of the way of dirt or grit.

The handle can be latched in the vertical position for manœuvring in confined spaces. By releasing the latch, the handle is freed to operate the hydraulic pump. For steering, the handle can be turned through 200 deg. when the three-way foot-operated control valve is in the centre or neutral position (the two end positions of the valve are the " lift " and " lower " positions). Since the jack is located vertically above the front axle the load is transmitted directly to the trunnion-mounted front wheels which may be rubber-tyred, or of solid aluminium or cast iron. This design greatly reduces the pull required, particularly on rough floors.

The chamfered fork tips reduce the possibility of damaging the pallet or stillage. In addition, the retracting mechanism is completely protected from damage by the box-section forks. Due to the simple slot fitting, the trail wheel rollers can be easily removed for maintenance. The trail wheels are of solid steel and are mounted on ball bearings to give smooth running with the minimum of drag. Split trail wheels are available where required.

All exterior surfaces of the truck are rust-proofed and finished by a cellulose spray.



The Lansing Bagnall H.P. 50 hand pallet truck has a lifting capacity of 4,500 lb. with a service weight of 3 cwt. It is available with standard fork lengths from 36 in. to 72 in. and with overall fork widths of 22 in. or 27 in. The maximum lift is 6 in.

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RECTANGULAR-FACE CATHODE-RAY TUBE

One of the disadvantages of the normal circular-faced cathode-ray tube is that very often only a small horizontal strip can be used for the trace. However, a rectangular-face tube is now being produced in this country by Mullard Limited, Century House, Shaftesbury-avenue, London, W.C.2, which enables the trace to occupy the whole of the screen area. It also enables some space to be saved. The screen size of these tubes is 5½ in. by 1½ in. and they have a deflection sensitivity of approximately 0·2 mm. per volt. The normal anode voltage is 6-kV.

Labour Notes

RAILWAY WAGES

Publication of the interim report of the court of inquiry into the railway wage situation, on January 5, led, as had been hoped, to an early resumption of negotiations between the British Transport Commission and the National Union of Railwaymen, and to the suspension of the proposed railway strike.

At a meeting of rather less than two hours' duration on January 7, representatives of the two organisations agreed that between 50,000 and 60,000 men in the lowest-paid grades of the railway industry should receive further increases, of between 5*s.* and 8*s.* a week, in their basic wage rates. It was agreed that these increases should take effect as from last Monday and that they should be the final increases for those men in respect to the 15 per cent. wage claim submitted in July, 1953.

Sir Brian Robertson, the Commission's chairman, emphasised the importance of providing incentives to railwaymen to remain in the Commission's service and his proposals for a starting rate, with increases after one and two years' service, were accepted.

The increases agreed upon will result in a new starting rate for porters and similar grades of £6 11*s.* a week, 6*s.* more than in December last, and 13*s.* 6*d.* above the rate for 1953. In the third year of service, the basic rate for these men will be £6 15*s.* a week, 8*s.* more than in December and an advance of 17*s.* 6*d.* on the rate in 1953. Lengthmen and relayers will commence at £6 12*s.* a week, rising to £6 19*s.* in the third year of service, advances of from 14*s.* 6*d.* to 17*s.* 6*d.* on the rates for 1953.

NEED FOR WAGE STABILITY

It was obvious that the increases granted to the conciliation grades would affect the wage position of the enginemen, on whose behalf the Associated Society of Locomotive Engineers and Firemen recently accepted a settlement of wage claims by arbitration, and of the clerical staffs, whose union, the Transport Salaried Staffs' Association, was in progress of negotiation on further salary adjustments.

In an endeavour to solve these questions, and to determine the wage rates for the remaining members of the N.U.R. involved in the dispute, discussions between the Commission and officials of the three unions commenced last Monday. One of the points agreed upon at the meeting between the Commission and the N.U.R. on January 7 was that whatever advances might be conceded to these railwaymen would date from the day on which the new negotiations commenced, January 10.

On their side, the officials of the N.U.R. renewed the undertaking they gave the Commission in October, that they would seek to obtain the fullest co-operation from their members for measures aimed at increasing productivity and efficiency.

In a statement after the meeting, Sir Brian said that the Commission hoped that the agreement reached that day would provide a firm foundation for a period of wage stability. Such a period was vitally necessary.

FAIR WAGES IN STATE INDUSTRIES

Perhaps the most outstanding pronouncement of the court of inquiry, in its interim report, was its declaration that "the nation has provided by statute that there shall be a nationalised system of rail transport, which must be regarded as a public utility of the first importance. Having willed the end, the nation must will the means.

"This implies that employees of such a national service should receive a fair and adequate wage and that, in broad terms, the railwayman should be in no worse case than his colleague in a comparable industry."

The statement affirms a new principle of much importance in connection with the wages of all employees in publicly-owned undertakings. It appears to be likely to give rise to a great deal of controversy.

Hitherto, a leading argument of the nationalised industries has frequently been that they simply could not afford to meet the demands made upon them. As the court lays some blame on the Commission for using that argument, and suggests that it should not be used again, presumably ability to pay, which is ultimately the determining factor in wage negotiations with private firms, must no longer be expected to apply to the nationalised undertakings.

When stating their case before the court, the Commission had suggested that they had found themselves unable to pay as high rates of wages as they might otherwise have considered desirable, owing to their obligations under the Transport Act, 1947, to balance their accounts, taking one year with another.

After two years with a surplus, the Commission has incurred an accumulated deficit which amounted, at the end of 1953, to £27,300,000.

INTERPRETATION OF THE COMMISSION'S POWERS

The court also expresses the view that "it is plain that there is no substance in the argument that there is an absolute statutory bar which prevents the Commission from paying such rates of wages as may involve them in any particular year in a deficit."

Commenting on this statement, a spokesman of the Commission said last Sunday that the Commission had not advanced any such argument. They had claimed, however, that the relevant section of the Transport Act gave them a warning that, as the responsible body, they must in the long run maintain the solvency of the undertaking entrusted to them by Parliament and that they must so exercise the discretion required of them in regulating their financial policy that, taking one year with another, their revenues balanced their outgoings.

The Commission, therefore, had always taken the view that Parliament did not intend them to enter upon agreements which were likely to involve them in deficits for an indefinite period of years.

The court criticises the Commission because the N.U.R. had been "exasperated and frustrated" by the efforts of the Commission to maintain contradictory positions throughout the negotiations.

On the other hand, the union was not exonerated from blame for its share in the dispute. According to the court, the union acted improperly in rejecting the October agreement on increases for operating grades other than footplate men, especially as its members were accepting payment at the new rates provided by the agreement.

DOCKERS' WAGE RATES

Some 70,000 dock employees are affected by the decision of a delegate conference in London on January 6 to accept an offer from the port employers of an increase of 16*s.* 6*d.* on the guaranteed minimum wage, bringing it up to £5 4*s.* 6*d.* a week, and of 1*s.* a turn in attendance money, raising it to a total of 6*s.* a half-day.

The guaranteed wage is applicable where dockers have reported for employment throughout a particular week, but whose earnings, owing to insufficient work being available, have been less than the guaranteed minimum. In such cases, the difference between the man's earnings and the guaranteed minimum is made up from the port employment fund, which is formed by a levy on the port employers.

Attendance money is payable to dock workers for each half-day on which they report for work without finding any available.

Following the recent exclusion of the National Amalgamated Stevedores and Dockers from the trade-union side of the National Joint Council for the Dock Industry, requests to the port employers for increases in the guaranteed minimum wage, and in attendance money, were made by the three remaining unions after the settlement of the last dock strike.

The unions concerned were the National Union of General and Municipal Workers, the Transport and General Workers' Union, and the Scottish Transport and General Workers' Union.

COAL PRODUCTION IN 1954

Miners in Britain failed last year to produce all the coal that was expected of them. That production had been lagging behind the target set for the industry had been known for some time, but only now, when provisional figures for the year as a whole have become available, has it been possible to see how far there has been a falling short of expectations.

Total production during 1954 and the previous year, 1953, has been striking level, according to statistics issued by the Ministry of Fuel and Power, with 223,795,100 tons mined during the former year and 223,519,000 tons during the latter year, an increase of only 276,100 tons.

Deep-mined coal produced amounted to 213,551,200 tons during 1954, compared with 211,820,900 tons during the previous year, an increase of 1,730,300 tons, or less than 1·0 per cent. In a recent review of the industry's record for 1954, Sir Hubert Houldsworth, the chairman of the National Coal Board, referred to his disappointment that that increase had not been nearer to the target of a 2½ per cent. increase set before the industry at the beginning of the year.

The increase in the production of deep-mined coal was almost balanced by a decrease in the production of opencast coal. Production from this source declined from 11,698,100 tons in 1953 to 10,243,900 tons last year.

DECEMBER'S GOOD EMPLOYMENT RECORD

There was a decline of 7,000 between November 15 and December 6 in the number of persons unemployed, bringing the total at the latter date to 256,000, according to statistics issued by the Ministry of Labour and National Service at the end of last week.

This total was the lowest December figure for any year since the war ended. It means that only 1·2 per cent. of all available employees were out of work last December, compared with 1·5 per cent. in December, 1953.

Persons in civil employment (industry, commerce and services of all kinds) numbered 22,680,000 at the end of November last, an increase of 50,000 on the total at the end of October. There was an increase of 40,000 in the manufacturing industries, including one of 30,000 in the engineering, metals-trades, and vehicle-manufacturing group.

Employees reported to be working overtime in manufacturing establishments rendering returns, during the week ended November 27, 1954, numbered 1,690,000. This figure was 180,000 above the level for August last.

NOTICES OF MEETINGS

Association of Bronze and Brass Founders

LONDON
"Shell Moulding," by J. L. Rice. Meeting arranged under the Association's advisory service scheme. Clarendon Restaurant, Hammersmith, W.6. Thurs., Jan. 20, 7.15 p.m. Preceded by meeting of member firms only at 4 p.m.

British Institution of Radio Engineers

EDINBURGH
"Modern Ship-to-Shore Communication," by G. Macdonald. Scottish Section. Department of Natural Philosophy, The University, Edinburgh. Thurs., Jan 20, 7 p.m.

Chemical Society

CAMBRIDGE
"Recent Advances in Acetylene Chemistry," by Professor R. A. Raphael. Cambridge Branch. Chemical Laboratory, The University, Cambridge. Fri., Jan. 21, 8.30 p.m.

Diesel Engine Users Association

LONDON
"Life Tests on a Small High-Duty Engine, with Particular Reference to Chromium Bores," by B. W. Millington. Caxton Hall, Westimster, S.W.1. Thurs., Jan. 20, 2.30 p.m.

Illuminating Engineering Society

GLOUCESTER
"Modern Trends in Picture Presentation," by F. W. Capbell. Gloucester and Cheltenham Centre. Offices of the General Electric Co., Ltd., 2 St. Aldate-street, Gloucester. Tues., Jan. 18, 6.30 p.m.
LIVERPOOL
Discussion on "Application of Light in Medicine." Liverpool Centre. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Tues., Jan. 18, 6.30 p.m.
MANCHESTER
"Lighting for Decoration," by P. Corry and A. E. Hurst. Manchester Centre. Offices of the North-Western Electricity Board, Town Hall, Manchester. Thurs., Jan. 20, 6 p.m.
PRESTON
"Lighting for Enjoyment," by T. O. Freeth. North Lancashire Group. Offices of the North-Western Electricity Board, 19 Friargate, Preston. Wed., Jan 19, 7.15 p.m.

Incorporated Plant Engineers

BLACKBURN
"An Introduction to Atomic Energy," by J. A. Dixon. Blackburn Branch. Golden Lion Hotel, Blackburn. Thurs., Jan 20, 7.30 p.m.
BRISTOL
"Space Heating and the Plant Engineer," by T. H. F. Holman. Western Branch. Grand Hotel, Bristol. Wed., Jan 19, 7.15 p.m.
CARDIFF
"General Hydraulics," by F. H. Fowler. South Wales Branch. South Wales Institute of Engineers, Park-place, Cardiff. Tues., Jan 18, 7.15 p.m.
GLASGOW
Open Discussion. Glasgow Branch. Scottish Building Centre, 425/427 Sauchiehall-street, Glasgow. Wed., Jan. 19, 7 p.m.
ROCHESTER
"Industrial Space Heating," by J. Evans. Kent Branch Bull Hotel, Rochester. Wed., Jan 19, 7 p.m.

Institute of British Foundrymen

COVENTRY
"Metallurgical Problems in Casting Aluminium and Magnesium Alloys," by Dr. W. A. Baker. Coventry Section. Technical College, Coventry. Tues., Jan 18, 7.30 p.m.
NOTTINGHAM
"Some Aspects of Shell Moulding," by D. F. Bailey. East Midlands Branch. Gas Board's Showrooms, Nottingham. Sat., Jan. 22, 6 p.m.
SLOUGH
Film Evening. Slough Section. Offices of High Duty Alloys Ltd., Slough. Tues., Jan. 18, 7.30 p.m.

Institute of Fuel

LONDON
"The Beaver Report," by Dr. G. E. Foxwell. Institution of Civil Engineers, Great George-street, S.W.1. Thurs., Jan. 20, 5.30 p.m.
BIRMINGHAM
"Locomotive Testing, with Special Reference to Fuel Economy," by D. R. Carling. Midland Section. James Watt Memorial Institute, Great Charles-street, Birmingham. Tues., Jan. 18, 6 p.m.
GLASGOW
"Recovery of Sulphur from Coke-Oven Gas by the Collin Process," by T. H. Williams. Scottish Section. Royal Technical College, Glasgow. Fri., Jan 21, 7 p.m.
SHEFFIELD
"Investigation of Fluid-Flow Problems by Model Techniques," by F. A. Gray and A. D. Robertson. Yorkshire Section. Royal Victoria Station Hotel, Sheffield. Wed., Jan 19, 2.30 p.m.

Institute of Marine Engineers

LONDON
"Deck Machinery," by W. H. Booth. Student Lecture. Mon., Jan. 17, 6.30 p.m.
BATH
"Marine Diesel Engines," by A. G. Arnold. West of England Section. York House Hotel, George-street, Bath. Mon., Jan. 17, 7.30 p.m.
SUNDERLAND
"Modern Developments in Steering Gear," by W. Spencer Paulin. North-East Coast Section. Technical College, Sunderland. Thurs., Jan. 20, 6.15 p.m.

Institute of Metals

SHEFFIELD
"Metallurgical Research in the Electrical Industry," by Dr. Ivor Jenkins. University of Sheffield, St. George's-square, Sheffield. Mon., Jan. 17, 7.30 p.m.

Institute of Road Transport Engineers

LONDON
"Accidents: Their Causes and Prevention," by G. Mackenzie Junner. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Thurs., Jan. 20, 6.30 p.m.
LEEDS
"Thin-Walled Bearings," by P. T. Holligan. Yorkshire Centre. Hotel Metropole, King-street, Leeds. Thurs., Jan. 20, 7.30 p.m.
LIVERPOOL
"A New Paper on Carburation," by L. J. Spencer. North-West Centre. Adelphi Hotel, Liverpool. Wed., Jan. 19, 7.30 p.m.

Institute of Welding

CHATHAM
"Argonaut Welding Process," by P. T. Houldcroft. Medway Section. Sun Hotel, Chatham. Wed., Jan. 19, 7.45 p.m.
GLASGOW
"Welding in Shipbuilding," by E. Cuthbert. West of Scotland Branch. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Wed., Jan. 19, 7 p.m.
LEICESTER
"Automatic Arc Welding," by A. Bean and E. T. J. Harbron. East Midlands Branch. College of Commerce and Technology, Leicester. Thurs., Jan. 20, 7.15 p.m.
SHEFFIELD
Film Evening. Sheffield Branch. Sheffield College of Commerce and Technology, Sheffield. Mon., Jan. 17, 7.15 p.m.

Institution of Chemical Engineers

LONDON
"Performance Data for Expanded Metal Column Packing," by H. R. C. Pratt and J. A. McWilliams; and "The Mechanism of Drop Formation from Gas or Vapour Bubbles," by F. Knelmann, N. Dombrowski and Professor D. M. Newitt. Geological Society, Burlington House, Piccadilly, W.1. Tues., Jan. 18, 5.30 p.m.

Institution of Civil Engineers

LONDON
"New Northam Bridge, Southampton," by F. L. Wooldridge, John Cuerel and K. R. Hauch. Tues., Jan. 18, 5.30 p.m.

Institution of Electrical Engineers

LONDON
Discussion on "The Human Operator in Closed-Loop Control Systems," opened by Professor C. Holt Smith. Measurements Section. Tues., Jan. 18, 5.30 p.m.
Discussion on "Education and Training for Engineers and Craftsmen in France," opened by R. G. Bellamy. Education Discussion Circle. Wed., Jan. 19, 6 p.m.
"Design, Performance and Application of Miniature Circuit-Breakers," by H. W. Wolff and T. G. F. Atherton. Utilization Section. Thurs., Jan. 20, 5.30 p.m.
FARNBOROUGH
"Possibilities of a Cross-Channel Power Link Between the British and French Supply Systems," by D. P. Sayers, M. E. Laborde and F. J. Lane. Southern Centre. Royal Aeronautical Establishment Technical College, Farnborough. Fri., Jan. 21, 6.30 p.m.
READING
"Post-Office and Power Overhead Lines: New Methods of Guarding," by S. J. Little and G. Fielding. District Meeting. George Hotel, Reading. Mon., Jan. 17, 7.15 p.m.

Institution of Engineering Designers

BRADFORD
"Recent Developments in Rolling Type Gear Testers," with film, by J. Horne. Yorkshire Branch. Midland Hotel, Bradford. Wed., Jan. 19, 8 p.m.

Institution of Engineers and Shipbuilders in Scotland

DUNDEE
"Experiences in the Stabilisation of Ships," by Sir William Wallace. Joint Meeting with Dundee Institute of Engineers. University College, Dundee. Mon., Jan. 17, 7.15 p.m.

Institution of Heating and Ventilating Engineers

LONDON
"Engineering Services in a Laboratory," by J. C. Knight. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Wed., Jan. 19, 6 p.m.
BIRMINGHAM
"Meteorological Data and Design Temperatures," by H. C. Jamieson. Birmingham Branch. Imperial Hotel, Birmingham. Thurs., Jan. 20, 6.30 p.m.

Institution of Mechanical Engineers

LONDON
Discussion on "Modern Trends in Controls for Boiler Plants." Steam Group. Tues., Jan. 18, 6.45 p.m.
Thomas Lowe Gray Lecture on "Some Factors in the Selection of Machinery for Cargo Liners," by Commander (E) L. Baker. Fri., Jan. 21, 5.30 p.m.
BRISTOL
Address by the retiring chairman, A. B. Cooper. Western Branch. Grand Hotel, Bristol. Tues., Jan. 18, 7 p.m.
FARNBOROUGH
Annual General Meeting. Southern Branch. Royal Aircraft Establishment Technical College, Farnborough. Wed., Jan. 19, 7.30 p.m.
MANCHESTER
"Inspection, Explosion and Breakdown of Boilers and Pressure Vessels," by J. Eyers. Annual General Meeting. North-Western Branch. Engineers' Club, Albert-square, Manchester. Thurs., Jan. 20, 6.45 p.m.

Institution of Production Engineers

BIRMINGHAM
"Silver and Electro-Plate: Antique and Modern," by I. Shortt. Birmingham Section. James Watt Memorial Institute, Great Charles-street, Birmingham. Wed., Jan. 19, 7 p.m.
DERBY
"Glass Production," by C. E. Stubbs. Derby Section. College of Art, Green-lane, Derby. Mon., Jan. 17, 7 p.m.
GLASGOW
"Shell Moulding," by D. N. Buttrey. Glasgow Section. 39 Elmbank-crescent, Glasgow. Thurs., Jan. 20, 7.30 p.m.
NEWCASTLE-UPON-TYNE
"Fundamentals of Machine-Tool Design," by C. A. Sparkes. North-Eastern Section. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Mon., Jan. 17, 7 p.m.
SOUTHAMPTON
"Modern Finishing Processes," by K. W. Abineri. Southern Section. Polygon Hotel, Southampton. Thurs., Jan. 20, 7.15 p.m.
SWANSEA
"Production Control," by R. G. Hitchcock. West Wales Section. Central Library, Alexandra-road, Swansea. Fri., Jan. 21, 7.30 p.m.

Institution of the Rubber Industry

LEICESTER
"High Energy Irradiation of Rubber and Plastics," by Dr. A. Charlesby. Leicester Section. Bell Hotel, Leicester. Tues., Jan. 18, 7.30 p.m.
LIVERPOOL
"Developments in Mixing Techniques," by J. J. S. Bates. Merseyside Section. 24 Hatton-garden, Liverpool. Mon., Jan. 17, 7 p.m.

Institution of Structural Engineers

GLASGOW
"A Graphical Approach to the Design of Two and Three-Span Rigid-Frame Buildings," by Hugh Fraser and W. G. Cantlay. Scottish Branch. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow. Tues., Jan. 18, 7 p.m.
LEEDS
"Construction of the Woodhead New Tunnel," by F. A. Charman. Yorkshire Branch. Great Northern Hotel, Leeds. Wed., Jan. 19, 6.30 p.m.

Junior Institution of Engineers

LONDON
"Delegation of Responsibility and Authority," by A. S. Trollip. Fri., Jan. 21, 7 p.m.

Manchester Association of Engineers

MANCHESTER
"Modern Methods of Sewage Treatment," by F. W. Allen and W. Foster. Engineers' Club, Albert-square, Manchester. Fri., Jan. 21, 6.45 p.m.

Reinforced Concrete Association

LONDON
"Reinforced Concrete in Coast-Protection Works," by J. A. Lewis. Institution of Structural Engineers, 11 Upper Belgrave-street, S.W.1. Wed., Jan. 19, 6 p.m.

Royal Aeronautical Society

LONDON
"Manufacture of Integral Structures," by Dr. E. G. West. Tues., Jan 18, 7 p.m.

Royal Society of Arts

LONDON
"Research in the Coal Industry," by Dr. W. Idris Jones. Cadman Memorial Lecture. Wed., Jan. 19, 2.30 p.m.

Royal Statistical Society

NEWCASTLE-UPON-TYNE
"The Design of Industrial Experiments," by Dr. N. L. Franklin. North-Eastern Industrial Applications Group. Armstrong Buildings, King's College, Newcastle-upon-Tyne. Wed., Jan. 19, 7 p.m.

Sheffield Metallurgical Association

SHEFFIELD
Chairman's Address on "The Passing of the Chemist," by F. E. Eborall. Annual General Meeting. Methods of Analysis Group. B.I.S.R.A. Laboratories, Hoyle-street, Sheffield, 3. Tues., Jan. 18, 7 p.m.

Sheffield Society of Engineers and Metallurgists

SHEFFIELD
"Metallurgical Research in the Electrical Industry," by Dr. I. Jenkins. University Building, St. George's-square, Sheffield. Mon., Jan. 17, 7.30 p.m.

Society of Chemical Industry

LONDON
Annual Conversazione and Exhibition of the Corrosion Group. Battersea Polytechnic, S.W.11. Thurs., Jan. 20, 6.30 p.m.

West of Scotland Iron and Steel Institute

GLASGOW
"Open-Hearth Furnaces," by J. L. Adamson. Fri., Jan. 21, 6.45 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

Association of Bronze and Brass Founders, 69 Harborne-road, Edgbaston, Birmingham 15. (Edgbaston 4141.)
British Institution of Radio Engineers, 9 Bedford-square, London, W.C.1. (MUSeum 1901.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Diesel Engine Users Association, 56 Victoria-street, London, S.W.1. (VICtoria 6161.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 48 Drury-lane, Solihull, Birmingham. (Solihull 3021.)
Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester 3. (Blackfriars 6178.)
Institute of Fuel, 18 Devonshire-street, Portland-place, London, W.1. (LANgham 7124.)
Institute of Marine Engineers, 85 The Minories, London, E.C.3. (ROYal 8493.)
Institute of Metals, 4 Grosvenor-gardens, London, S.W.1. (SLOane 6233.)
Institute of Road Transport Engineers, 69 Victoria-street, London, S.W.1. (ABBey 6248.)
Institute of Welding, 2 Buckingham Palace-gardens, London, S.W.1. (SLOane 9851.)
Institution of Chemical Engineers, 56 Victoria-street, London, S.W.1. (VICtoria 6161.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineering Designers, 38 Portland-place, London, W.1. (LANgham 8847.)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. (Central 5181.)
Institution of Heating and Ventilating Engineers, 49 Cadogan-square, London, S.W.1. (SLOane 3158.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Institution of the Rubber Industry, 12 Whitehall, London, S.W.1. (WHItehall 5012.)
Institution of Structural Engineers, 11 Upper Belgrave-street, London, S.W.1. (SLOane 7128.)
Junior Institution of Engineers, Pepys House, 14 Rochester-row, London, S.W.1. (VICtoria 0786.)
Manchester Association of Engineers, 20 Booth-street, Manchester, 2. (Central 2796.)
Reinforced Concrete Association, 94-98 Petty France, London, S.W.1. (ABBey 4504.)
Royal Aeronautical Society, 4 Hamilton-place, London, W.1. (GROsvenor 3515.)
Royal Society of Arts, John Adam-street, Adelphi, London, W.C.2. (TRAfalgar 2366.)
Royal Statistical Society, 21 Bentinck-street, London, W.1. (WELbeck 7638.)
Sheffield Metallurgical Association, 15 Crescent-road, Sheffield 7. (Sheffield 53674.)
Sheffield Society of Engineers and Metallurgists, University of Sheffield, St. George's-square, Sheffield 1. (Sheffield 24071.)
Society of Chemical Industry, 56 Victoria-street, London, S.W.1. (VICtoria 5215.)
West of Scotland Iron and Steel Institute, 39 Elmbank-crescent, Glasgow, C.2. (Central 5181.)